

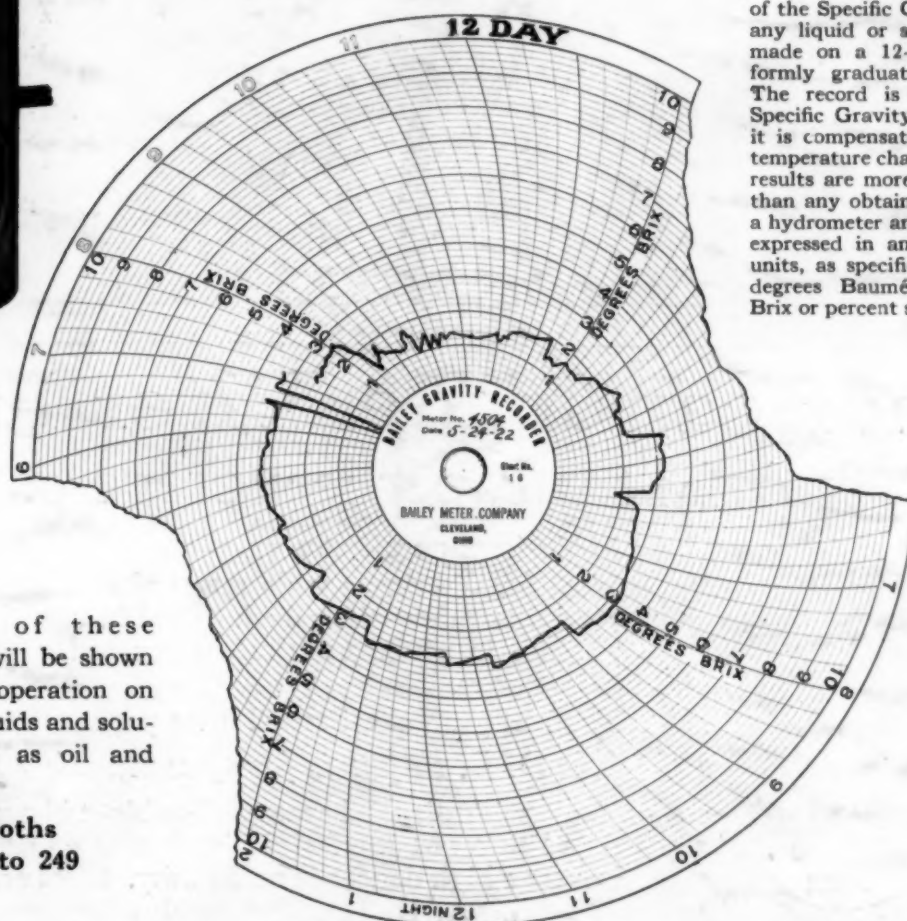
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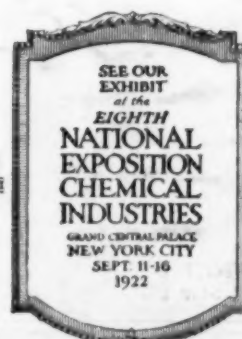
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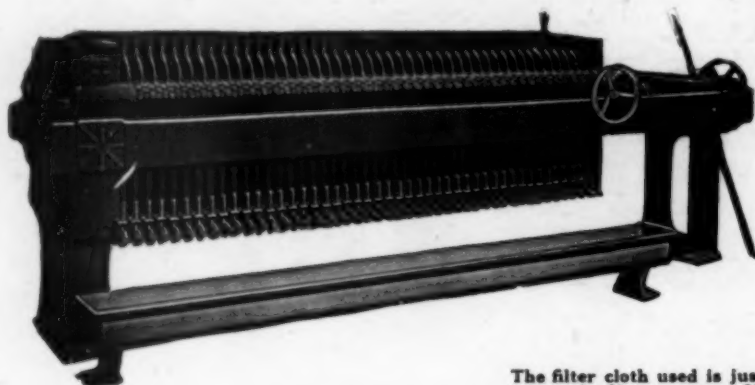
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Number 7

The Tariff on Its Last Lap in the Senate

SUSPENSE regarding the Senate's action on the tariff will be ended on August 19, when, according to an agreement reached last week, the final vote will be taken. There will be a certain sense of relief on the part of the interested public when the vote is finally announced, even though the provisions of the bill cannot possibly satisfy everyone concerned. As the Senate has proceeded with the consideration of the bill and has successively taken its action on dye embargo, potash, wool and sugar, apparently without rhyme, reason or any attempt at consistency, the average citizen has grown dizzy in an effort to follow all the gyrations and forecast the final outcome.

As far as the chemical industries are concerned, the picture is not entirely devoid of relief from the deep blue in which some have painted it. It is true that the dye embargo has now been eliminated by both the House and Senate and that the only hope for its further consideration is to have the Senate replace it in the bill on final vote next Saturday. If this is not accomplished, the feature is lost, because the conferees will have no power to consider it again.

On the other hand, little fault can be found with the ad valorem and specific rates to be levied on coal-tar chemicals. This is particularly true when we consider that the Senate has applied the principle of American valuation to dyes and chemicals covered in sections 25 and 26 of the chemical schedule, with a further reinforcement in the form of the flexible tariff provision of the bill which gives the President the power to alter rates as much as 50 per cent in order to rectify inequalities in cost of production abroad and at home. Of course we would rather have the embargo, and we still hope that it will prevail; but if it does not, the dye industry will have obtained a large measure of protection.

The outlook for potash is not so favorable. The Senate fairly ran amuck in considering this item, not only eliminating from the bill the proposed sliding scale of duties, but also declining to consider a bounty on production. In other words, potash was thrown out of the Senate, bag and baggage. And unless it receives some consideration on final vote the matter will have to be fought out in conference committee, for the House bill contains provision for a sliding tariff.

As intimated above, the Senate has just taken action on two important matters, both of which will favor the chemical industry. These are the application of American valuation to imports of coal-tar dyes and chemicals and the so-called flexible tariff provision that gives the President the power to raise or lower the rates as much as 50 per cent. In adopting both of these provisions the Senate made radical changes in the original pro-

posals. American valuation was first applied to all commodities, but under an attack led by Senator LENROOT, the proposal was amended so as to apply only to coal-tar dyes and chemicals. The provision for flexibility in the rates was strongly opposed by those who object to vesting in the Executive the tax-levying power of the Congress. Nevertheless the President's own preference for flexibility in the tariff undoubtedly had some influence in the Senate's adoption of the measure. According to its provisions the Tariff Commission will aid the President in determining the difference in cost of production of commodities abroad and at home. The President cannot change a specific duty to an ad valorem duty, or vice versa, nor can he transfer articles from the dutiable and free lists. An important amendment to the original measure was one providing for public hearings by the Tariff Commission. In ascertaining the difference in the cost of production the President is directed to take into consideration the advantages granted to foreign nationals by their governments.

Considering the belligerent attitude of some of the Senators and the fact that the Senate has already greatly modified the House bill, it is practically impossible to forecast the final action on any of these provisions. These will be determined only by agreement among the conferees of the House and Senate.

The Bedrock of Facts and Figures

IN PLEDGING their whole-hearted support to the work of the new Chemical Division seventy-seven of our organic chemical manufacturers have added their approval to the constructive service which the Department of Commerce is rendering to industry. As more funds become available Secretary HOOVER's plans are gradually taking effect and it is increasingly evident that the department under his direction will reach and serve practically every branch of business.

It is peculiarly significant that the chemical manufacturers' first demand on the division is for statistics. Apparently even the monthly figures for the imports and exports of dyes have already proved their value to these practical business men. It is well known that a part of the dye industry must look to the world markets for the disposition of surplus production that is inevitable with efficient operation. Likewise other factors in the industry must keep closest tab on incoming goods, for their market may be swept away by a tide of imports. These industries want the actual facts and figures on which to base the control of their individual businesses.

But accurate information on production, consumption and stocks is even more vital—both to industry and to the country at large. The primary cause of runaway markets during a period of inflation is usually the lack

of just such data. Distribution is carried on unintelligently. Stocks pile up in one place and shortage exists in another. With the latter comes a false demand which in turn results in overproduction, market demoralization and loss.

The new Chemical Division, if given support, can become a valuable distributor of the essential business statistics of the industry. Furthermore, our trade associations—those representing the manufacturing chemists, the synthetic organic chemical manufacturers and the chemical equipment producers—are ideal agencies for carrying on this work, and they will be ably assisted by the government and by such national organizations as the Chamber of Commerce of the United States. What is most needed is the support of the individual business man, who must be made to realize the necessity for furnishing his quota of the needed data. Industry will not be guided intelligently until he is willing to take the guess out of his own business and get down to the bedrock of facts and figures.

Armchair Chemistry And Its Value

RECENTLY there was abstracted in *Chemical Abstracts* a paper entitled "Odor Value Analysis." In it a theory was advanced that odor is the response of the olfactory nerves to intermolecular vibration. It was further advanced that each pure substance has its own rate of vibration, which may, however, be too high or too low to be detected, just as there is in vision an ultra-violet and an infra-red region. It was further pointed out that most substances having any perceptible odor are unsaturated in the chemical sense. In addition, the authors have stated that odor undoubtedly could be modified by the addition of substances which do not of themselves have a very characteristic odor. Many substances become almost odorless as they approach purity, and yet when the impurity is isolated, it itself has almost no odor. The final suggestion is that since this theory would indicate that perfumers are wasting large quantities of material simply by nullification, constructive research would consist of the design of the most delicate kind of instrument and the most careful scientific work.

This paper interested us a great deal. The suggestion is interesting in itself and the theory might prove to be workable and the result far reaching. It is the kind of paper that often makes technicians and research men scornful, saying that it is an armchair paper representing no laboratory work of any kind and proving nothing. We can sympathize with that attitude, for we always seem to sense a trace of superiority in such articles, an attitude which might be translated to mean, "Let other people do the manual labor, we have done the thinking." Yet with all the objections, such papers have a vital place in research. Too often the research man is wrapped up in the details of manipulation. With his nose too close to the grindstone, he fails to get his problems in proper perspective. He often misses some valuable leads.

This same criticism can be applied with tremendous force to industrial research. The "vital" problems of industrial research are too often problems involving merely technique. How valuable it would be for industry if there were some men who could sit back and suggest things which "can't be done."

For Him Who Runs

SOMETIMES we wonder whether readers of this magazine know of and appreciate the excellent work that is being done on behalf of business by the Fabricated Production Department of the Chamber of Commerce of the United States. An able series of bulletins and pamphlets has been prepared, the last of which came to our notice some months ago. It is entitled "Perpetual Inventory or Stores Control." In our opinion there is not a manufacturing executive today who can afford to neglect the subject matter of this pamphlet. Doubtless the same information can be obtained from other sources, for there are books and articles on the subject and experts ready to give advice. But the service which the Chamber of Commerce is performing in this connection, making available expert knowledge on many phases of business, deserves the approbation of those in whose interest the work is done.

Another report recently received from this organization announces that uniform cost accounting has been adopted in approximately 120 lines of commodities. It mentions the benefits which accrue from a uniform system. First of all it inspires confidence that selling prices are determined on a fair basis and thus makes possible more intelligent competition. Obviously if costs are figured in a haphazard manner one man may be a serious detriment to an industry by selling at a price which he thinks would return a fair profit but which actually entails loss. Finally uniform cost-accounting systems reveal at once the unprofitable commodities in any manufacturing enterprise.

We have mentioned but two of the topics on which the Chamber of Commerce has rendered signal service to business. Executives who will take the trouble to keep in close touch with this organization will find their time and effort amply rewarded.

Sawing Off the Branch On Which They Sit

QUITE recently the fact that engineers and technical men are intermediaries between labor and capital has been given much greater recognition. Upon them capital must depend for the efficient carrying out of processes. It must count on their loyalty and enthusiasm to make possible that extra percentage of yield upon which the success of the whole enterprise may depend. This enthusiasm is no abstract thing; it is translated into everyday work. For example: A somewhat disheveled foreigner sticks his head inside the little office of the plant foreman or the chemist in charge. "Da pomp he leak," he grunts. "All right, JOHN," replies the chemist. If the technical man is loyal, eager, enthusiastic, he will go at once and repair the pump or see that it is repaired. If for any reason enthusiasm is lacking, he will sit around a while before he moves. Those minutes spell money!

Hence the enthusiasm of the technical man is the most valuable asset of chemical corporations. To do anything to diminish this enthusiasm would seem, on the face of it, blind and absurd. And yet in the past few years how many companies are there who have not cut the salaries of technical men, often out of proportion to the reductions made in other salaries and wages? Ten, twenty or thirty per cent cut from the payroll of the company seems like money well saved to the board of

directors or the executive who is pinched in his yearly budget. But is it? If these executives and boards of directors had only had close contact with plants, they would realize that the money saved on the books shows up as money lost through little items none of which is evident in the cost accounts. How enthusiastically will a technical man throw himself into his work if his services have just been re-estimated at 80 per cent of their former value? It is a problem in elementary human nature, and one that can be solved if the executives will only put on a pair of overalls and stay around any chemical plant for a few days.

At the same time that the salary cuts were being made, it is likely that the company was calling upon the loyalty of its employees. How little such companies understand elementary psychology! Loyalty can never be given when the aim of the corporation and the aspirations of the individual do not coincide. Upon that principle hangs all the law and the "profit."

A "Bucket Shop"

In Chemical Industry

IT LOOKS as though we have been unwittingly guilty of aiding and abetting the operations of a company that has the earmarks of a wildcat in the chemical industry. Last winter we printed in our Searchlight Section an advertisement announcing positions in the engineering, chemical, traffic and sales departments of a company purporting to manufacture metallic aluminum and aluminum compounds. A 3-year minimum contract at a good salary with annual increases was offered to successful applicants. It was stipulated, however, that they must take a financial interest in the company, which would be "solidly protected." "These are not 'jobs,' but positions with real future ahead." With thousands of chemists unemployed, it is small wonder that there was generous response to the advertisement.

It appears now, however, that the glitter was not gold but basest dross. A correspondent recently told us that he left a good position to become factory superintendent for this outfit and that while he was there he produced 3 tons of alum, which was "the only salable material which the company ever made." He found a rather desperate situation, with workmen unpaid and dissatisfied, and he dug into his own pocket to assist their families. He personally received only part of his salary and when he left the company it owed him several hundred dollars on personal account and for money advanced to the workmen. Subsequently he saw the glittering advertisement which was published in *Chem. & Met.* and other technical journals and straightway protested at the main office of the company, accusing the officials of bad faith. He was urged not to "spill the beans." The officials took him into their confidence and showed the actual situation. Among other things there was a stack of replies to the advertisement from men offering to "invest" anywhere from \$500 to \$30,000 for a good job. Our correspondent's protest against this method of doing business having failed, he promptly resigned.

Since then several men are reported to have "invested" in the company after leaving good jobs, and the company has meanwhile been ousted from its manufacturing plant. Other correspondents tell of having applied for positions and of growing wary when they learned that they might be tied to a lot of incompetent men who had "invested" in the company and could not be discharged.

Whenever an incident of this kind occurs we feel that

an apology is due to our readers, because they are entitled to protection against the operations of wildcat and fake concerns. Needless to say, this advertisement slipped into our columns despite a standing regulation that should have prevented it. The lines have been tightened still further, however, and we believe that our readers will be safe from future exploitation by irresponsible advertisers. The reader is entitled to feel that he can place the same confidence in an advertisement that he does in the text of a technical magazine, and it is the publisher's duty to throw every possible safeguard around him and merit his confidence. In return the reader should give prompt notification of cases such as the one here cited so that immediate exposure can be made and further dupes prevented from investing in a chemical bucket shop.

New Ideas

For Old Industries

SEVERAL weeks ago we published an article describing a revolution in the production methods of porcelain manufacture—a revolution that was wrought by men having no prior acquaintance with the industry. Long trained and thoroughly skilled in the production methods of other industries, they brought to the porcelain field a new viewpoint. They studied this field in the light of their previous experience, and by judiciously combining what they had learned elsewhere with the fundamental necessities in porcelain manufacture they accomplished truly remarkable results in increased production and lowered costs.

This also brings to mind an experience some years ago of a brewer acquaintance of ours. In the course of his business dealings he acquired the burden of ownership of a bankrupt motorcar plant. As this property stood when our friend acquired it, it was much more of a liability than an asset. Our friend made beer, and at that time hoped to continue to do so; and so he viewed his new property as something to get rid of as soon as he advantageously could. After some study, he determined that the fault was with the motorcar plant management and not with the product. So he carefully reorganized this management, using what he knew of brewing business methods as a basis and disregarding the mushroom-grown methods then prevalent in the automotive industry.

The results obtained were highly satisfactory, to say the least. In 3 years time he had established a steady market for his car, the plant was running profitably, and he was able to sell the property for a splendid sum. The impetus of his reforms holds to this day and the present owners have cut many coupons as a result of business ideas brought into their plant from a totally foreign industry.

It is with a knowledge of the possibilities of the outside viewpoint in mind, a knowledge based on many examples other than those cited above, that we are often filled with wonder at the attitude of so many plant owners and executives. They are so often hesitant to employ an engineer unless he has had years of experience in their own industry. And they angrily tell the consultant that he cannot hope to show them anything of value about a game of which he knows nothing and they know almost everything. Surely, if we will but delve a bit into our memories, we can all find examples at least as pointed as those given here of the surprising growth of the seed of a new idea when planted in the fertile soil of an old industry.

Readers' Views and Comments

Castings of Electric Iron

To the Editor of *Chemical & Metallurgical Engineering*

SIR:—Mr. Elliott, in his excellent paper read before the last meeting of the Electrochemical Society on "Cast Iron as Produced in the Electric Furnace, and Some of Its Problems" and republished in your magazine of July 19, thoroughly covers the subject from the standpoint of practice and utility. While the conditions as enumerated are those of Cincinnati or such other center near by blast furnaces, they do not hold on the Pacific Coast. To operate a cupola our problem is the obtaining of pig iron of quality and sufficient cheapness together with cheap cast-iron scrap. Freight on Eastern iron amounts to \$14 to \$19 per ton, depending on whether shipped by rail or water. Foreign irons can be laid down on the dock at about \$30, but of questionable quality in the majority of cases. Cast scrap is now selling at about \$23 per ton, and steel scrap for general melting at \$14. As against these you have steel borings selling at \$6 and cast iron borings selling at \$7. With a conversion cost of \$12 to \$15 per ton in the electric furnace working on cheap scrap, you can readily see where cold melting is more economical than the refining of hot metal from a cupola.

When the Los Angeles Foundry Co. first started manufacturing electric furnace cast iron an acid bottom furnace was used, but this was quickly changed to basic, when it was found that we could not make a quality casting in the acid furnace. We have tried both duplexing and cold melting and prefer cold melt iron to duplex iron for several reasons:

1. It can be made from steel scrap with a low phosphorus content, giving a much stronger iron.
2. It can be melted down under strong reducing atmosphere with a carbide slag. This means that the period of refining is lengthened from $\frac{1}{2}$ hour to about 3 hours. What is more important, the slag protects the metal during the period of fusing and melting, and before there has been any chance for the metal to dissolve oxides or gases which later cannot be removed.
3. Metal is never exposed to chance oxidation, as happens in the cupola when not properly running. It is a well-known fact that very often iron can be oxidized in the cupola, and even the most rigorous basic electric furnace refining will never bring that iron back into the quality class.

Electric iron is always more difficult to machine than cupola iron, and I thoroughly agree with Mr. Elliott that this is caused primarily by the elimination of microscopic gas pockets giving a much denser and sounder iron. Electric iron, however, can be so manufactured that it will have all of the excellent qualities of basic iron, and yet can be machined at high rates of speed. At the present time we are making gray iron castings of the analysis: carbon 3.25 to 3.75 per cent, silicon 2.00 to 2.50 per cent, manganese 0.30 to 0.50 per cent, sulphur less than 0.04 per cent, phosphorus less than 0.05 per cent which fills the conditions perfectly.

The above is a general statement of the conditions in the southern Pacific Coast region and especially

under our conditions of operation, and while they are indicative of our experience, they may vary greatly in other sections of the country. The freight problem is a serious one out here, and from the general trend I can see a great expansion in the manufacture of electric furnace iron in the future. With the wonderful development of the power companies there is the assurance of abundant electric energy to serve our future needs.

LARRY J. BARTON.

Los Angeles Foundry Co.,
Los Angeles, Calif.

Chemists in Public Life

To the Editor of *Chemical & Metallurgical Engineering*

SIR:—I wish to thank you for sending me the July 5 issue of *Chemical & Metallurgical Engineering*, as I was very much interested in your editorial review of the question of the public and semi-public activities of chemists. Personally I think you have put your finger upon the weakness of the chemical profession, if it may be so called. In my very humble opinion, the reason the public has failed to appreciate chemistry and chemists has been due to the fact that chemists, as a class, have failed to distinguish themselves in the communities in which they live from the large group of manual workers. The reason for their tendency to become recluses and for their lack of interest in public affairs has always been a source of wonderment to me. University professors, as a rule, are not so subject to this criticism, since they are, by the very nature of their work, forced into a larger participation in community affairs, unless they are research men.

As to the reasons for this condition, it has seemed to me that our university and college courses in chemistry lack what may be called directional emphasis. As a result a chemistry student who has seen the emphasis placed on laboratory work associates this in his mind as the goal of chemical training. If our colleges and universities had a short course in what may be called "vocational guidance for chemistry students," in which could be pointed out the opportunities for executive, administrative or consulting work and in which the obligation or opportunity of the chemist to his community could also be indicated, I believe the situation would improve within a generation.

As you know, I am connected with a company which receives a great many applications for positions each year from graduates of our universities. In practically every case the applicant asks for laboratory work and ceases to be interested when informed that the only openings available are in the operating, sales or administrative departments. In other words, the opportunity to use his training for what may be called mental tasks does not seem to appeal as does the opportunity to use his hands in mere mechanical laboratory work. I always wonder if laboratory work as such does not have a certain "play" appeal and possibly gratifies the instinct possessed by us all to manipulate apparatus in order to enjoy the glow of satisfaction derived from the successful outcome of the experiment.

Chicago, Ill.

S. L. REDMAN.

The Business Side of Chemical Manufacture

BY CHARLES WADSWORTH, 3D

IF A young doctor has as much money at the end of a year as he had at the beginning and has paid his expenses, he calls it a good year. That may sound rather rudimentary as accounting. It is. But it is not a whit more rudimentary than most commercial cost finding until quite recent years.

Of course it must be remembered that there was not nearly so imperative a need for accurate costs until within the last 30 years. Previous to that time the world was a manufacturers' market. Demand was always in excess of production, or nearly always. Manufacturing efficiency was not so perfect and it was nearly impossible to flood the market in a short time. Therefore the selling price of a commodity was a comfortable fraction above manufacturing costs. Since the margin was not so close, the less complex problems of markets and distribution permitted the manufacturer to read the pulse of his business from a number of indicators which experience has taught him to respect, such as sales, cash balance, bills receivable, bills due and the general feeling of health or the reverse.

Modern cost accounting is a much more reliable and a much more flexible method of observing and controlling any business. It is becoming a prerequisite to intelligent executive action. The modern executive cannot possibly keep in touch with his business as the old-time business head could. Therefore accurate cost analysis is coming to be his business eye.

ONE DANGER OF COST ACCOUNTING

There is one very great danger in this and it is the danger into which many large corporations have fallen. Cost analyses look much the same in one business as in another. So, frequently, a successful executive in one line of business sees a set of cost figures from another line of business and as they look perfectly intelligible, he is confident that he understands them. He sees what the trouble is. He says so. Boards of directors believe him. He is invited to take charge of such and such a company. If this new company is a chemical manufacturing company and he has had no experience in that industry, heaven help the company. Even executives who have grown up in chemical plants, but whose main contact is now through costs, often do absurd things. In our last article on plant yield we mentioned an almost universal example of lack of executive contact with manufacturing conditions. The query as to why such and such a yield is low or such and such a cost is high when the variation observed is within the possible limits of accuracy illustrates the lack of executive contact and the danger of depending too much on costs.

THE AIMS OF COST ACCOUNTING

Cost accounting must be developed as a theoretical system first and then some practical considerations discussed. Naturally, in an article such as this, telegraphic brevity and glaring omissions must be the rule,

but we can perhaps give some conception of the advantages, the difficulties and the methods of cost accounting in chemical plants. Many manufacturers have objected, and many still do, that their business is unique and ordinary cost accounting could not be applied. They further object to the cost of installation and operation. Finally, when it's all in, what have you got? Can you tell him anything that he doesn't know? He's getting as much as the market will stand for all his products and he's making money!

The answer should be cautious and not sweeping. Cost accounting, Mr. Manufacturer, will tell you many things that you don't know. It will show you what factors go into the manufacturing cost and it will enable you to put your finger on the items that are costing too much. It will segregate the selling cost and indicate whether that is too high. It will enable you to determine which of your products is the best money maker. Perhaps some are actually losing money. It will show you the definite price limits of raw materials and labor. It is true that the system will cost something to install and something to operate. The forms cost money to print and take time to fill them out. The accounting department will have to be increased. But the expense will be small compared with the gain. We urge you to try it, but not until you and your whole organization understand and believe in cost accounting. Your men must realize that it is not a spy system and that it is to their interest to make the system accurate and dependable. Unless they are behind it the system will have relatively small value. (Many fail to appreciate the necessity of the co-operation of the men in this work.)

HOW ACCURATE ARE COSTS?

As we discuss the details of cost accounting it will be readily seen that the accuracy of the system will be directly proportional to its cost. The point of marginal utility must be determined. For example, it might be possible to estimate costs with an accuracy of 10 per cent under a given system. With a few more forms and an extra clerk or so the accuracy might well be increased plus or minus 2 per cent. Still further refinement would be possible at increased cost, but might be considered unnecessary. For example, assume that handling and trucking of material amounted to a considerable item. The total cost might be split equally among the products. However, an accurate distribution could be obtained only through a voucher and order system. This might make a difference in cost of some of the products amounting to several per cent, due to greater accuracy of distributing the charges. Is that greater accuracy worth while? It is a question which must be specific, but which should always be asked. Relatively few do ask the question, for the tendency is, if you have a cost system, to go the whole hog and install many wholly unnecessary forms.

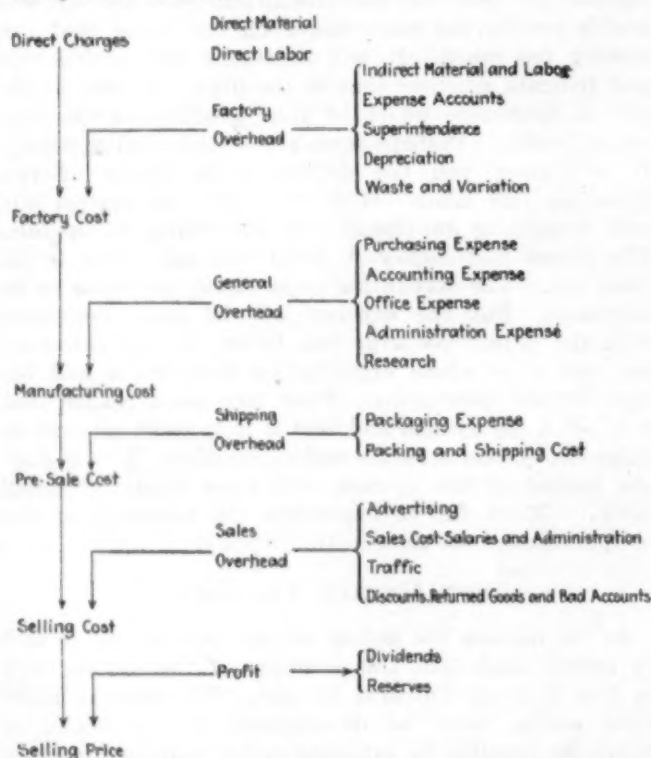
This Article, the Sixth of the Series, Presents the Purposes, the Limitations and the Great Advantages of Cost Accounting—The Methods Are Briefly Discussed and a Few of the Practical Difficulties Enumerated

All cost accounts are based on systematic arrangements of expenditures. Payments by the company are recorded in books of original entry, usually called journals to distinguish them from ledgers, which are the books of final entry. A typical journal account would be "payrolls," to which all money paid to employees would be debited each week. The account is then credited as the various amounts are charged out to the plants in which the employees worked. When the credits equal the debits the account is said to be balanced or "wiped out." Journal accounts are wiped out as frequently as possible.

Those items of cost which can be charged directly from the journal accounts to the departments as above are called Direct Charges. These are of two kinds—Direct Material and Direct Labor. The terms signify that the material and labor so itemized were definitely used in that process. That much of cost finding is simple, accurate, unquestionable—BUT

INDIRECT CHARGES—THE REAL PROBLEM OF COST ACCOUNTING

Before we go further a simple diagram will help to clarify the situation.



The next group of charges to be considered are the indirect charges called in the diagram Factory Overhead. All charges except labor and material are indirect or overhead charges. The above grouping is somewhat arbitrary, but is a very frequent practice and can be commended because it is comprehensible. Indirect charges cannot be made directly from the books of original entry to the proper ledger account. The charges are first grouped under intermediate accounts with proper headings. For example, the journal payroll account is debited to process ledger accounts and, as far as repair and shop men go, to a shop account which is an intermediate account. From this account time is charged out on a basis of orders by different plants. Another type of indirect charge is an account such as superintendence which is split up not by an order system but on an arbitrary percentage basis.

One general principle which should be followed in making indirect charges is that under no circumstances should an extraordinarily large charge be made in a given period to boost the cost of production unduly. If a large amount of repair work is undertaken in a given month or fortnight it would be decidedly unfair to charge all of that repair work to the cost of making the material produced in that short time. To avoid this a special account is opened called deferred charges to expense and this account is gradually wiped out by crediting monthly (or fortnightly) charges made to various ledger accounts. This is also the method for handling such charges as taxes and insurance where payments are made once or twice a year and the amount distributed to the various producers periodically.

If we now return to the diagram the various items deserve some more detailed consideration.

Indirect Labor and Material—For example, repairs are made on a piece of equipment. The wages of the shop men, machinists, carpenters, etc., are charged out of the Payroll Account into a shop account and then the time consumed on that particular repair job is charged against the department in question. Similarly, the material used on the repair has been debited to Stores and is now charged out to the department. Again, oilers and motor repair men who work in a number of departments are charged to a general account and the account divided appropriately. Material handling and trucking in the factory are also included in indirect labor.

Expense Accounts are more difficult still. Such items as steam, electric power, compressed air, rent, taxes, insurance can not be easily evaluated for a given product. The total cost of such items for the whole plant must be obtained by accumulating all the charges in accounts with proper headings. Then these charges must be distributed according to the amount of steam or air or power consumed or, in case of rent or insurance, according to the value of that part of the property used by each department. Obviously this involves either measurement or estimation of the quantities distributed in the first instance. This can be accomplished with more or less inaccuracy.

Superintendence is again an item the total cost of which must be divided. Shall the division be based upon the capital value of the individual plant, upon the total value of the product made, or upon an estimated proportion of time spent on each plant? In instances where the superintendence charges are high, the policy of distribution would make an appreciable difference. This brings us to a generalization which is extremely important. *Costs can be made to vary to an amazing extent depending on the policy of distributing overhead charges.*

This will become more and more apparent, and right there is the meat of the whole problem of cost accounting. It is the reason why standardization of costs is difficult. One manufacturer distributes his overhead charges according to the capital value of his respective units, another according to the value of the product made. One may include research as a capital charge to be written off. Another prefers to write it off in current expenses. All these variations make for variations in cost. In other words, it amounts to this: The distribution of indirect charges is a matter of business policy and this fact makes it impossible to say *this* is the right way to distribute your overhead charges.

There can therefore be no absolute method or figure for costs no matter how accurately the system is devised. It is well to bear these facts in mind when you are dealing with costs. They are not heaven-sent mathematical certainties, but they represent an intelligent approximation and the most valuable instruments yet devised for determining business health.

DEPRECIATION—THE GREASED PIG OF COST ACCOUNTING

A prime example of the effect of business policy upon costs is evident from the treatment of *Depreciation*. A good friend of mine remarked that a discussion of depreciation resembled a debate on free will or determinism. It reached no definite conclusion as to what was ultimately correct. Depreciation represents the diminution in value which equipment or buildings undergo with use and time. Some accountants believe that depreciation should be figured at a definite per cent of the original value. A machine costing \$5,000 if depreciated at 10 per cent per year would have values of \$4,500, \$4,000, \$3,500, etc., at each succeeding year. Another theory would depreciate at a fixed per cent of that year's value. (\$5,000 at 10 per cent equals \$4,500 at the end of 1 year; \$4,500 at 10 per cent equals \$4,050 at the end of 2 years, etc.) Others believe that depreciation should be modified to correspond with the replacement value of the equipment. For example, at the end of 3 years the cost of the \$5,000 machine is actually \$6,000. Ought not the amount written off be a definite percentage of \$6,000 instead of \$5,000?

Remember the theory behind depreciation is to set aside out of profits a reserve for replacement of equipment. It has always seemed to me that the simplest method of figuring depreciation should be followed and the percentage set high enough so that there is a definite factor of safety in it. The same policy should be adopted in determining depreciation that is used in deciding about the installation of new types of equipment. In some industries—for example, cement—new equipment is installed if it can show a 20 per cent return on the investment. Therefore a conservative depreciation rate in that industry would be between 10 to 15 and a normal depreciation about 10 per cent.

Many industries and firms are foolishly demanding and frequently miss extremely good investments on that account. They will not invest in changes of equipment unless the return amounts to 100 per cent in a year. Heavy chemical firms are notably conservative investors and their depreciation rates are usually high.

Another refinement in estimating depreciation consists of estimating the rate on each piece of equipment separately or each major piece costing over a definite amount. Except as a method of arriving at the average depreciation in a given unit, this does not seem necessary or wise. What you are after really is an adequate reserve for replacement and an estimate of the capital value of the plant on which interest must be earned. It can be rather easily understood if a small company be considered, with investment of \$50,000 in equipment. The value of that equipment will depreciate at, say, 10 per cent a year. Then in 2 years it will be worth \$40,000. Out of the profits a reserve for depreciation should have been set aside in that time of \$10,000. Thus the total capital will be the same.

As a matter of fact this is not universally done. Firms will spend a tremendous amount of time estimating depreciation rates with great care so that costs

will be accurate and income taxes as low as possible, but no cash reserve is set aside for depreciation in any way. It is just a book figure and has only theoretical significance.

Still another factor of depreciation is commonly called *Obsolescence*. It refers to the decrease in value of a machine due to the development of better manufacturing processes. In some industries obsolescence is a much larger factor than depreciation, and in all businesses it must be considered.

There is yet another difficulty introduced into cost accounting by the necessity of meeting definite specifications. Some of the material may not come up to standard, in which case it may either have to be marketed at a loss, discarded completely or worked off in batches of standard material. The cost treatment obviously will vary with the method of disposing of the material. The treatment of waste, or spoilage as it is called, is most difficult when the material must be discarded. How shall the loss involved be treated? Shall it be accumulated in a special account and written off in small monthly increments, or charged off once a year in the profit and loss account? The former way is preferable.

GENERAL OVERHEAD

Following the desirable doctrine of simplicity, a large majority of firms add all the charges for purchasing and stores, such as salaries, wages, etc., to one general account. This account is fairly regular and is wiped out each month (or period) by debiting it proportionally to the ledger accounts. There is a more complicated method which consists of wiping out the purchasing and stores accounts by adding a small fixed charge to everything that is purchased to cover the cost of purchasing. This requires more bookkeeping and is scarcely worth the effort.

An exactly similar procedure to that given in the first part of the last paragraph can be followed with the distribution of Accounting Department Expense, Office Expense and Administration Expense. Each of these items is fairly steady and thus the general overhead does not offer as much complication as the factory overhead. The amount varies very slightly from month to month and it is entirely safe to wipe out the account from month to month. No deferred charges need arise. The differentiation of the General Overhead from Factory Overhead is entirely logical. Even in firms which operate only one factory and therefore do not compare one factory cost with another, the practice is desirable. The types of accounts are quite different.

COST OF PACKAGING AND SHIPPING

Just a word is needed on this point. The charges embraced in this heading are not strictly manufacturing charges and should therefore be segregated under a separate heading. This is exceedingly convenient, as the cost of this item is frequently higher than necessary. Much attention is devoted to production efficiency in the plant and often many hundreds of dollars are wasted by letting this item slide by.

In many industries there are very big problems involved in this work. Carboys, barrels, drums, etc., are returnable and represent a very large capital investment in themselves. Definite regulations in the crediting of these items must be followed and enough margin allowed to take care of repairs. Replacements should

take care of themselves. The whole container system should as nearly as possible be on a self-supporting basis. This is usually taken care of by a service charge included in the price of the commodity and credited to a special fund for taking care of these items.

SELLING OVERHEAD

Finally, after production expense is all accumulated, the cost of selling the product must be added. This means that the cost of advertising, the sales department expenses, including many items not usually thought about, such as warehousing expenses, freight to distributing points, trucking, etc., must be collected in appropriate accounts. There is opportunity for many complications in this work. Take this little problem. Sulphuric acid and alum are sold by one firm. Assume that sulphuric acid is placed largely on contract during October, whereas alum is sold largely on spot sales throughout the year. The volume of sales is the same as to cash value, but the alum is literally ten times as difficult and expensive to market. Is it fair to split the selling expense equally? In such a clear-cut case as the above it might be possible to make a fair distribution, but in practice such clear differentiation does not exist. Therefore distribution is usually carried out on the simpler basis of cash value of product.

COMPUTING SELLING PRICES

With the addition of the selling overhead we have completed the compilation of the total cost of the product. To this must now be added whatever profit is to be made in order to determine the selling price. That sounds like putting the cart before the horse. Many executives and most salesmen would be inclined to laugh at "adding whatever profit is to be made." The idea is that the most you can get is the correct profit. However, the mechanism of calculating minimum prices and the extensive use of these in the chemical industry make the above statement pertinent. One of the main advantages of cost accounting is that it will tell you when a product is losing money and it is losing money when the total cost plus a fair return on the capital invested is greater than the selling price.

INTEREST ON BORROWED MONEY

Up to the present time no mention has been made of interest on borrowed capital. Many cost accountants believe that it should be considered an expense and treated exactly as an expense account is treated. It is more logical, however, not to include it in the manufacturing cost. If the capital was not borrowed, but subscribed by the owner, there would be no such item in the cost. Therefore it should be taken out of profits and not added as an expense. This is a rather moot question and the confusion arises from the fact that interest on bonded debt or stock dividends must be paid and are therefore regarded as fixed expenses. Actually, however, they do not belong in manufacturing cost. The disposal of profits to proper reserves, etc., is not a problem of cost accounting but of business policy, and does not belong here.

Some Plant Problems in Cost Accounting

Cost of Raw Materials. It is easy enough to write down the cost of material when it is purchased from an outside source at a definite cost. But suppose you made a product in one department, consumed part of

it in another department and sold the rest, how much should department 2 pay for product made in department 1? Shall it pay market price or manufacturing cost? There is no correct way of handling this problem. It is a matter of business policy solely. It will make a decided difference in the profit made on either product and executive decisions must in either case take into consideration these variations.

Joint Products and Byproducts are also difficult to handle, since any distribution of cost is arbitrary. The only fair way is to consider the profit on the group as a whole. Take the example of muriatic (hydrochloric) acid and saltcake (sodium sulphate). Both of these products are made in the same reaction. If an arbitrary distribution of overhead is made, it is conceivable that a greater profit might be found in muriatic, whereas on another basis a greater profit would accrue from salt cake. It would be folly therefore to specialize in the sale of one under the mistaken idea that more money could thus be made. The above is precisely what happened in another process in my own experience. Beware of squirrels!

Research is a difficult thing to handle from the accountant's standpoint. First, what is it? In addition to laboratory research, this item includes development work, drafting work, design and engineering work. In other words, all things tending toward production of material which do not represent real value. It is the "overhead" of plant construction cost. The distinction is not clean cut and is ultimately a matter of degree rather than kind.

For accounting purposes it can be divided into research on products already manufactured and research on new products. This division is somewhat dependent also on the kind of industry. Dyestuffs and fine chemicals have the largest ratio of research per unit capital and it is usual for them to write off the research charges into current expenses by adding an amount equal to an average of the past 3 months. This procedure is desirable, as dye processes may have very irregular use and may not be able to bear their share of any amortization of capital charges annually.

POSTLUDE

Do you now resemble the sweet young lady who told the clergyman that he had made the subject of free will perfectly intelligible? Do you understand cost accounting perfectly? Well, neither does anyone else, but as it is the greatest single aid to intelligent production, it would not be a bad idea to study it.

This series of articles on the Business Side of Chemical Manufacturing ends with this article. This means simply that the six articles originally planned have been published. Other articles will appear from time to time, and we have the promise of special articles on these non-technical phases of chemical manufacture from eminent specialists. The subject is too vital to leave and it shall be one of the purposes of *Chemical & Metallurgical Engineering* to awaken the technical man to the vital nature of non-technical work and to the necessity of his mastering the technique of these departments if he is to attain to effective executive positions. At present he is too much dominated by the business man whose mastery of business technique has made him more valuable to industry than the technical man without it. This has been bad for industry as well as for the technical man.

A Visit to the Plant of the Nobel Industries, Ltd., at Ardeer, Scotland

BY ELLWOOD HENDRICK

AN INTERESTING feature of the Glasgow meeting of the Society of Chemical Industry was the visit to the Ardeer works of the Nobel Industries, Ltd. The party was restricted to 100 persons, who left Glasgow on a special train and arrived at the factory about 10 a.m. Here, after giving up all smoking materials, cigar lighters and matches, the visiting company was divided into several groups of about twenty, each group being placed in charge of one of the chemists of the establishment for an inspection of their various departments. The passage through the sulphuric acid and nitric acid plants was just rapid enough to be a bit tantalizing, but the whole tour gave a clear idea of the general arrangement of the works. At noon the company met in the great hall of the club building for lunch. Sir Hugh Anstruther, vice-chairman of the board, presided and Lord Cochrane of Caith, together with one or two other directors of the corporation, was present as well as many of the staff. A quality of measured and proper conviviality reigned which was unusual to those of us who are accustomed to lead from dryness rather than the bottle on festal occasions.

The chairman made a short address in which he declared that their research staff had been their key to progress. Business, he said, was dull; they were working only 5 days in the week; but they continued to promote research at all times with energy and fervor, as their best means of making advancement. Without it they could not have done their work during the war successfully, nor could they have continued to produce needed things up to the armistice. Dr. Armstrong, the new president of the Society, made a happy response, and then the company was off again to witness a series of demonstrations of the testing of blasting explosives and demonstrations of some of the properties and of several applications of explosives.

It was noted in a descriptive pamphlet given to each visitor that in some explosives, such as black powder, the burning of successive layers of the substance takes place at a velocity of only a few meters per second, whereas in the more modern blasting explosives the combustion travels through the mass at from 1,000 to over 8,000 meters per second. This rapid type of explosion is called detonation, and the impulse passing through the mass is called the detonating wave. A few

detonating explosives, such as mercury fulminate, flash almost immediately when ignited, whereas others explode only after burning for some time; or they may burn up entirely without detonating. The former more sensitive detonators are used to initiate the wave in the latter. Thus a metal tube containing the initiating explosive is imbedded in the mass of the other and then ignited by safety fuse or an electrically ignited composition, which detonates the main explosive.

EXPERIMENTAL DEMONSTRATIONS

Three experiments showed the difference between an explosion caused by rapid burning and one due to rapid detonation. The demonstrations included an explosion of gunpowder by safety fuse alone; an explosion of dynamite by a detonator fired by a safety fuse; the explosion of dynamite by a detonator fired electrically. A second series showed 8 oz. of Cambrite No. 2 ignited by a flame and 8 oz. of Cambrite No. 2 detonated by a No. 6 detonator. The differences were very marked and the experiments most instructive. Demonstrations were also made of the testing of blasting explosives. The "power" of an explosive is a function of the actual pressure developed by the products of decomposition, which are chiefly gaseous at the time, and of the velocity at which the pressure is developed. To determine the former, the lead block test is made.

The apparatus for this test is a lead cylinder containing a cylindrical cavity into which a given weight of the explosive to be tested is placed, tamped with dry sand, and fired. The cavity so produced is measured by pouring water into it from a measuring cylinder and comparing it with the amount needed to fill the bore before the explosion. This determines the shattering effect.

The ballistic mortar test determines the gas pressure developed or the heaving effect. In this test, the explosive is contained in a horizontal cavity in a steel block or mortar which forms the bob of a huge pendulum. The shot is tamped by means of another steel block which forms a sliding fit into the first. When the shot is fired the tamping block is propelled into a sand bed beyond it and the pendulum is swung back in the opposite direction. A marker shows how far, on a circular scale, the pendulum has swung.

VELOCITY OF DETONATION

The velocity detonation test is an important factor in testing the quality of an explosive and the method is very ingenious. A quick explosion is suitable where the size of the fragments is of no importance, but if too great pulverizing action is to be avoided, as in quarrying or getting out coal, then an explosive of comparatively slow detonation is desired.

The apparatus consists of a thin lead tube containing a core of TNT. This is called "TNT fuse," because the detonation wave travels through TNT at a very uniform rate. If a length of this tube is detonated simultaneously at each end, the detonation wave will meet at exactly the middle point of the fuse, and this point may be readily found by laying the fuse on a lead bar; then the point at which the detonation waves meet is clearly shown by the presence of a fine line across the lead bar, perpendicular to the fuse. But if the ends of the fuse are detonated successively by a detonation wave which travels along a cartridge of known length of an explosive to be tested, then a certain time will elapse between the detonations at the respective ends of the TNT



FIG. 1—VIEW OF ARDEER FACTORY OF NOBEL'S EXPLOSIVES, LTD., SHOWING ACID PLANTS



FIG. 2—EXPLOSIVE MANUFACTURING BUILDINGS
AT ARDEER

fuse. In that case the line where the detonation waves meet will not be in the center, but somewhat to the side. This distance of the marking line from the exact middle from each end of the TNT fuse indicates the velocity of the detonation wave of the explosive which is tested.

SENSITIVENESS TO DETONATION TEST

If two cartridges of the same explosive are placed end to end on the ground and one of them is fired, the detonation of the first is transmitted to the other. If the experiment is repeated, gradually increasing the distance between the cartridges, it will be found that the range of transmission is not the same for all explosives. The maximum distance at which one cartridge can propagate explosion in another is known as the Ardeer double cartridge test or the "A.D.C." Cartridges were shown which failed to "catch" an explosion this way at 4 in. distance from the same kind of cartridges which were detonated, whereas another flared up when placed as far as 24 in. distant from a similar cartridge that was shot.

SAFETY EXPLOSIVES GALLERY TEST

This determines how far it is possible to go, or rather how much of a "safety" explosive may be fired in a mine in the presence of fire damp or coal dust. The company's "gallery" is a long steel chamber like a long boiler, into which a mixture of coal gas is introduced and openings in the gallery are sealed with paper. Coal gas is introduced so as to produce an explosive mixture with air. Then varying amounts of the explosives to be tested are shot into the container. When an explosion ensues, it is known that the limits of safety for that powder have been reached. Similar tests are made with coal dust and air mixtures.

The final series consisted of demonstrations of some properties and practical applications of explosives. Three dynamite cartridges were fired successively, the first in the open air, the second partly confined, and the third tamped on an iron plate. The third experiment showed a method in use for cutting steel plates in the destruction of old ships. To show the use of explosives in the removal of obstacles, a wooden palisade was set up and a row of cartridges laid close to the foot and confined by banks of the earth. To dig a trench for drainage purposes a row of holes was bored in the ground along the line of the proposed trench and a cartridge placed in each hole and exploded. A large cast-iron cylinder, which was the top section of a nitric acid pot condemned to the scrap heap, was broken into two pieces

by the application of a plaster charge to the inner face of that portion of the ring which was next the ground.

A large cast-iron pot was also consigned to the scrap heap, but owing to its size and shape, a plaster shot would have been dangerous on account of the flying pieces of metal. In this demonstration the pot was filled with water and the explosive suspended in the center and fired. The water acted as a transmission medium, causing a heaving pressure against the sides of the pot, breaking it up into small pieces very effectively and within a comparatively small area. Then followed demonstrations of distress and sound signals designed for ships at sea, and finally a chimney stack was demolished and caused to fall in a definite direction by removing bricks from the base of the stack, leaving only supporting pillars on the side on which it was required to fall. The pillars were then bored and charged with the required weight of explosive.

An extensive exhibition was provided in the club building of materials made by the corporation at its various plants which, besides explosives and the heavy chemicals to make them, included gas mantles, celluloid materials, nitrocellulose cements and varnishes, plastic wood, metal goods, bicycles, soaps and other materials.

Heat-Treating Steel Castings to Spheroidize Cementite

By using proper magnification, it is usually possible to resolve the eutectoid areas of well-annealed carbon steels into lamellar pearlite. It has ordinarily been supposed that an extremely long anneal just below A_c , is necessary to spheroidize the structure—i.e., cause the cementite plates in the pearlite to break and ball up into small spheres, through the influence of surface tension.

H. C. Ilson points out, in *July Forging and Heat Treating*, that a steel having spheroidized cementite is analogous to a good bearing metal, in that it contains small hard particles which resist wear imbedded in a relatively soft, tough matrix. He tested some open-hearth cast steel (C 1.0 per cent, Mn 0.71, P 0.045, S 0.042 and Si 0.37) which after annealing 2 hours at 1,400 deg. F. showed a pearlite structure, coarse fracture and the following physical properties: tensile strength 103,100 lb. per sq.in., yield point 56,640 lb. per sq.in., elongation 6 per cent in 2 in., reduction in area 6.3 per cent, and Brinell hardness 233. A_{c1} for this steel was at 1,325 deg. F., and A_{cm} 1,485.

Results of several heat-treatments are given, from which it appears that after correct preliminary heat-treatment, this steel can be spheroidized by a 1-hour draw at 1,300 deg. F. Best results were had by a rather complex heat-treatment: Anneal 2 hours at 1,400 deg. F., to equalize the phosphorus and other solid solutions. Quench in oil after 30 minutes at 1,600 deg. C. to effect fine dispersion of the carbide. A similar quench from just above the lower critical (1,870 deg. F.) is then necessary to prepare for the spheroidizing, which is effected by 1-hour stay just below the transformation range (furnace cooled from 1,300 deg. F.). This treatment gives a test-bar having ultimate 98,550 lb. per sq. in., yield point 65,990, elongation 19.5 per cent, contraction 26.2 per cent and Brinell hardness of 196. Practically the same result, except that the contraction is about 20 per cent, may be had if the hardening treatment be omitted.

Commercial Furfural— Its Properties and Uses—I

BY CARL S. MINER, JOHN P. TRICKEY AND
HAROLD J. BROWNLEE

The Miner Laboratories, Chicago, Ill.

Part I of a Paper Describing This Laboratory Curiosity Which Has Lately Become an Important Industrial Aldehyde — Its Occurrence, Manufacture and Properties

FURFURAL occupies an anomalous position in the realm of chemistry. It was first prepared nearly a hundred years ago and for forty years it has been utilized in a standard and widely used analytical procedure. Yet furfural itself has remained until very recently a chemical curiosity, its chemical properties and even its very appearance practically unknown even to many who have frequently utilized its services in the determination of pentoses and pentosans. A considerable number of years ago, the senior author of this paper had occasion to make several hundred pentose determinations within a few months. Yet despite the fact that in each of these determinations he made furfural by boiling the carbohydrates with acid, distilled that furfural and precipitated it with phenylhydrazin, not once did he see any furfural, since, because of the solubility of furfural in water, no separation of it occurs during the distillation process. The general lack of knowledge of or interest in furfural on the part of the chemical profession becomes the more comprehensible when we realize that it has never been quoted at less than \$6.50 per lb. until very recently. Such a price has not encouraged laboratory experimentation nor any important commercial utilization.

Very recently the processes for manufacturing it have been developed to a point where it now sells for substantially less than benzaldehyde and current developments are such that one may confidently predict an ultimate price materially below that at which formaldehyde is now sold. Since it bids fair eventually to become the cheapest aldehydic body commercially available, it has seemed expedient at this time to present a summary of the present state of knowledge of furfural together with the bibliography of the subject which we have thus far compiled. Our own difficulty in finding information to aid us in our investigation of possible uses for the compound leads us to hope that the publication of this information may be helpful to the workers in this field during the formative period of what seems likely to become an important branch of American chemical industry.

OCCURRENCE AND PREPARATION

Furfural was first obtained by Dobereiner (1)* in 1830 while preparing formic acid by the action of sulphuric acid and manganese dioxide on sugar. During the distillation he noticed that the distillate came over milky and on standing, a yellow "oil" separated out. He succeeded in obtaining only a small amount, not enough to make any extensive investigation of its nature. The "oil" was described as having an odor similar to a mixture of oil of bitter almonds and oil of cinnamon and was given the name "artificial oil of ants." A short time later Emmet noticed that an "oil" was obtained when formic acid was prepared from rye or corn by treating with sulphuric acid.

Stenhouse (2, 6) in 1840 was the first to prepare any quantity of this "oil." He used Emmet's process for preparation of formic acid, using oatmeal and sawdust as the material from which to make the "oil." He succeeded in obtaining a yield of an ounce from twelve pounds of meal. The composition of the "oil" was determined and formula of C_5H_4O , given to the compound. This formula has been shown by subsequent investigation to be correct. The effect of treating it with acids and alkalis was studied, and its boiling point, specific gravity and solubilities in water and alcohol determined. Comparison of these constants with those determined more recently indicate that Stenhouse was working with a very impure product.

Fownes (3) in 1845 was the next to work on an "oil" obtained by distillation of bran with sulphuric acid. He found this to be identical with the "oil" studied by Stenhouse and suggested the name furfurol (furfur-bran, oleum-oil). Ultimately, when the aldehyde nature of the compound was established, it became known as furfuraldehyde, which is now ordinarily abbreviated to furfural. He also prepared the ammonia compound to which he gave the name furfurol amide (now furfuramide). The formulas for the two compounds were determined as C_5H_4O for furfurol and C_5H_4NO for furfurol amide. He also prepared a compound from the amide which he named furfurin and having the formula $C_5H_3N_2O$. Cahours (7) also obtained furfural from wheat by sulphuric acid distillation and prepared the amide and furfurin. Stenhouse in 1850 (6) prepared "oils" from various vegetable sources and found that these "oils" were similar, but from some classes of vegetable growth, especially seaweeds, there was an "oil" obtained which he claimed was an isomer of furfural and to which he gave the name fucusol. This compound gave an ammonia compound, fucusamide, and from this by action of dilute potassium hydroxide fucusin could be prepared. In later papers further study is made of fucusol and an acid is prepared analogous to the acid obtained by oxidation of furfural, pyromucic acid, to which he gave the name β -pyromucic acid.

Maquenne (15) and Tollens proved the fucusol of Stenhouse to be a mixture of furfural and methyl furfural. This is the first record of differentiation between furfural and methyl furfural, the product formed by hydrolysis of methyl pentosans.

Many others worked on furfural preparing it from a wide variety of materials such as cane sugar (4), wood (10), glucose (22), and albumen (21), and eventually it was found that pentoses and pentosans were the substances ordinarily yielding furfural, although in a few cases such as glucose, cane sugar, etc., furfural is produced in very small quantities from carbohydrates other than pentoses.

Neff, in his investigations of the actions of various oxidizing agents on glucose, has isolated a series of acids containing 1, 2, 3, 4, 5 and 6 carbon atoms. This reaction is not progressive, the acids being formed

*Numbers in parentheses refer to the bibliography which will be found at end of the second installment, to be published in *Chem. & Met. Eng.*, Aug. 23, 1922.

simultaneously. This phenomenon explains satisfactorily the fact that small amounts of furfural are produced by action of sulphuric acid on the hexoses. Sulphuric acid, being an oxidizing agent, first oxidizes the sugar to a five-carbon compound and from this the furfural is probably derived.

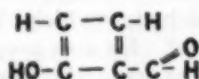
It has been shown that some proteins, especially the nucleo proteins, contain pentose groups, a fact which offers an explanation of the reported production of furfural from "albumen."

It was also found that furfural may be prepared by distillation of pentosans with concentrated solutions of zinc chloride, calcium chloride (5) and other acid salts, as well as by dry distillation. Furfural has been found in commercial fusel oil (109), glacial acetic acid (9), and sulphite-waste-liquors (19). In the case of fusel oil, the furfural was not the product of normal fermentation, but was found to be due to the action of certain acids on solids of the mash during distillation (17).

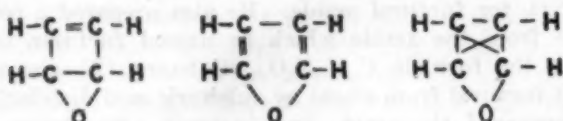
It may be noted that all the products in question where furfural occurs as an impurity have been subjected during the process of manufacture to conditions where a mixture of carbohydrates and acid may have been acted upon by heat.

STRUCTURE OF FURFURAL

Limpricht (29) in 1869, by studying the actions of the furfural group with bromine, chlorine, etc., proposes the formula

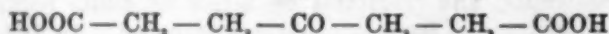


Baeyer (30) proposes the formulas

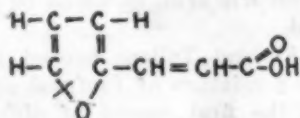


and from the results of his work considers formula 1 as representing the formula of the furfurane group.

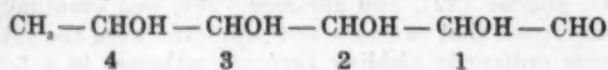
Pawlinoff (31) by means of the zinc ethyl reactions established the non-presence of any hydroxide group and favors formula 2 of Baeyer. Markwald prepared a keto acid from furfuracrylic acid having the formula



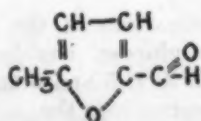
proving the position of the ketone group and concluded that the structure of the furfuracrylic acid is



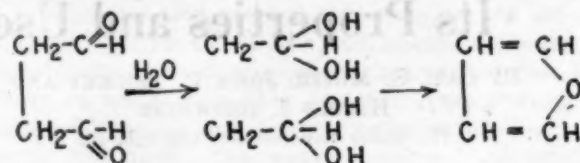
The break in the ring comes at the place indicated, in the forming of the keto acid. Tollens (35) and Maquenne (15) determined the structure of methyl furfural by its derivation for isodulcite



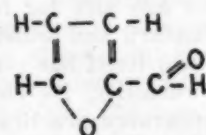
an anhydride being formed by the dehydration of the two alcoholic groups 1 and 4 to give the formula



Harris synthesizes furfurane by heating succinic-di-aldehyde with water as follows:



From this evidence the formula for furfural has been accepted as



MANUFACTURE

Until very recently furfural has not been manufactured in commercial quantities and although a number of methods of producing it have been proposed at various times, so far as we are able to learn very few of these have ever been practiced. In the case of those who have actually produced furfural on a commercial scale, very little publicity has been given to the methods used. We can only judge from such uncertain data as the patents issued to them or their published work. On this basis there is some reason to believe that much of the furfural which has been imported has been made from kapok waste by a method which, in a general way, approximates the laboratory procedure for the determination of pentosans, which consists in boiling the pentose-bearing material with 12 per cent hydrochloric acid and distilling. In this country, the excellent research conducted by the Bureau of Chemistry has developed a method not yet utilized commercially so far as we are aware, in which corn cobs or similar materials are treated in a stationary digester at comparatively high pressure without the introduction of acid. We understand that this process has been operated successfully on a semi-commercial scale in connection with the bureau's experimental work.

Our own investigations in this field have led us to select oat hulls as the most readily available raw material for the process, since they are produced continuously throughout the year in large quantities (as much as 200 tons a day at a single plant) by factories centrally located and in a form convenient for treatment. We have developed a simple and effective procedure in which the hulls are subjected to the action of steam and acid in large rotary digesters. By this method very satisfactory yields are obtained and the furfural is produced admixed with relatively small quantities of water. This process is now being operated successfully in a commercial production of furfural amounting to several tons per month, which production will be very greatly increased in the near future.

Since the theoretical yield of furfural from oat hulls is in the vicinity of 20 per cent and the annual production of oat hulls in the United States 220,000 tons, the possibilities of production of furfural from this source alone are enormous.

CHEMISTRY OF FURFURAL

In the following, a rather brief survey of the work done on the compounds of furfural has been made. Our endeavor has been to present a few of the typical examples showing in a general way the types of reac-

tions into which furfural enters and the chemical nature of the compound itself. In the bibliography appended, a much larger number of references will be found than are cited in the body of the paper.

But very little work has been done on the physical properties of furfural. Its boiling point has been determined by a number of workers with varying degrees of accuracy. Probably the most exact results are those of Mains, of the Bureau of Chemistry, recently published in *Chemical and Metallurgical Engineering* (260). Working on a highly purified product, he found the boiling point as 161.7 deg. C. at 760 mm. Its specific gravity was also determined by Mains as 1.1598^{20}_{vac} and 1.1545^{25}_{vac} . Its solubility in water and the composition density tables at 20 and 25 deg. C. he determined up to the saturation concentration. The solubility data are reproduced in Table I.

TABLE I—OBSERVED DATA ON MUTUAL SOLUBILITY OF FURFURAL AND WATER

Water Layer		Furfural Layer	
Temperature, Deg. C.	Per Cent Furfural by Weight	Per Cent, Deg. C.	Per Cent Furfural by Weight
16	8.12	8	96.5
17.0	8.18	26.6	94.6
27	8.72	37	93.3
27.2	8.72	44	92.8
27.5	8.68	65	90.9
44	9.80	70	90.3
61	11.9	84	88.0
66	12.5	96	84.5
92	17.0	....	....

Bruhl (80) determined its refractive index with the following results:

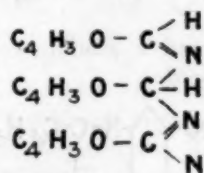
$$\begin{aligned}\mu_a &= 1.51862 \\ \mu_D &= 1.52608 \\ \mu_\beta &= 1.54566 \\ \mu_\gamma &= 1.56484\end{aligned}$$

Sir W. Ramsay determined its heat of formation as 5,985 cal. The flash point of furfural is 55 to 57 deg. C. Other physical constants of furfural are now the subject of investigation by several workers whose results will be published shortly.

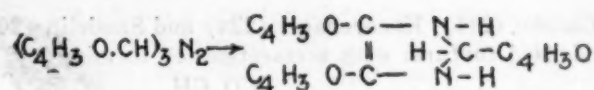
In general it resembles in its reactions benzaldehyde on one hand and formaldehyde on the other. It differs from both of them in being a liquid of very high boiling point and wide range of solvent power.

It was early discovered that furfural had many chemical characteristics in common with benzaldehyde, which led to a rather extensive study of its reactions with various aliphatic and aromatic compounds as well as the study of the reactions of furfural with ammonia, hydroxylamine, etc.

Among the earliest compounds prepared was furfuralamide. Stenhouse, Maquenne, Fownes and others prepared the compound, but its structure was first determined by R. Schiff to be

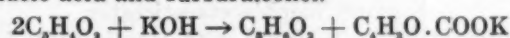


As the corresponding benzaldehyde ammonia compound is converted by treatment with dilute alkali solution into benzin, Bahrmann, Schiff and Cahours prepared furfural by similar treatment. Bertaglini (129) prepared furfural by simply heating furfuralamide at 110 to 120 deg. C. for about an hour.

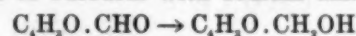


This compound is much more basic than furfuralamide, forming well-defined salts with acids and being alkaline to indicators. Ramsay (89) established that furfural was a secondary base with two replaceable hydrogens.

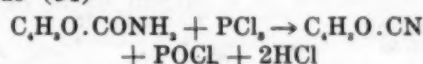
By the same method that benzaldehyde, by treatment with alcoholic KOH, is converted into benzylalcohol and benzoic acid, Schiff (97) and Limpricht (99) prepared pyromucic acid and furfuralcohol.



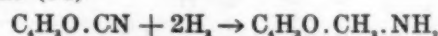
Pyromucic acid was also prepared by oxidation of furfural with silver oxide (96). Furfuralcohol prepared by reduction of furfural with sodium amalgam (95)



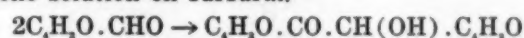
Furfurnitrile is prepared by action of PCl_5 on pyromucicamide (94)



The nitrile by reduction with zinc and H_2SO_4 to furfurylamine (94)



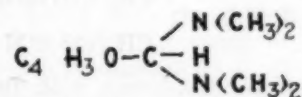
E. Fischer (88) prepared furoin by action of KCN in alcoholic solution on furfural.



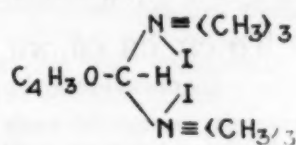
This compound oxidized gives furil, $\text{C}_4\text{H}_3\text{O}.\text{CO}.\text{CO}.\text{C}_4\text{H}_3\text{O}$. Fischer also prepared mixed compounds such as benzofuroin, $\text{C}_6\text{H}_5\text{O}.\text{CO}.\text{CH}(\text{OH}).\text{C}_4\text{H}_3\text{O}$, etc. Furfural forms condensation products with urea and related compounds.

The reactions of furfural with aliphatic compounds have been rather extensively studied. Priebs (237) studied the condensation of nitromethane in alkaline solutions preparing furfurnitroethylene, $\text{C}_4\text{H}_3\text{O}.\text{CH}:\text{CHNO}_2$, and from this compound by ordinary nitrating methods prepared nitrofurfurnitroethylene, $\text{C}_4\text{H}_3\text{O}(\text{NO}_2).\text{CH}:\text{CHNO}_2$, which on oxidation gave nitromucic acid, $\text{C}_4\text{H}_3\text{O}(\text{NO}_2).\text{COOH}$.

Litterscheid (236) prepared furfuryliden-methylamine, $\text{C}_4\text{H}_3\text{O}.\text{CH}:\text{NCH}_3$, by the action of furfural on methylamine, also the compound furfurylidentetramethylidiamine



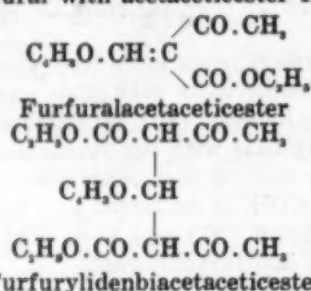
Both of these compounds form salts with acids and addition products with alkylhalides such as



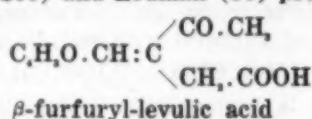
Claisen (233), Mehne (232) and Schmidt (231), prepared condensation products of furfural with acetone and acetaldehyde such as: Furfuralacrolein, $\text{C}_4\text{H}_3\text{O}.\text{CH}:\text{CH}.\text{CHO}$; furfuralacetone, $\text{C}_4\text{H}_3\text{O}.\text{CH}:\text{CH}.\text{CO}.\text{CH}_3$; difurfuralacetone, $\text{C}_4\text{H}_3\text{O}.\text{CH}:\text{CH}.\text{CO}.\text{CH}:\text{CH}.\text{C}_4\text{H}_3\text{O}$; as well as mixed compounds such as benzal-furfural-acetone, $\text{C}_6\text{H}_5\text{O}.\text{CH}:\text{CH}.\text{CO}.\text{CH}:\text{CH}.\text{C}_4\text{H}_3\text{O}$.

Claisen (226), Hill (228), and Markwald (227) condensed furfural with acetic acid forming furfuracrylic acid, $\text{C}_4\text{H}_3\text{O}.\text{CH}:\text{CH}.\text{COOH}$, and studied the halogen compounds of the acid.

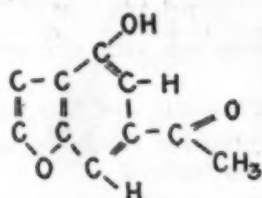
Claisen (211), Knoevenagel (224) and Sandelin (207) condensed furfural with acetacetic ester forming



By condensation of furfural with levulic acid, Ludwig (206), Kehrler (205) and Erdman (86) prepared

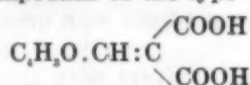


which on distillation in a current of H_2 or CO_2 condenses forming



Acetooxycumaron.

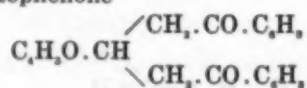
Succinic and malonic (154) acids condense with furfural forming compounds of the type



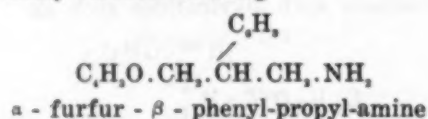
Similar reactions were studied by Rohmer (214), Volander (215), Tonnies (213) and others.

The action of phenylhydrazine, hydroxylamine, barbituric acid and phloroglucinol was studied in relation to the quantitative determinations of furfural, pentoses and pentosans. Tollens, Cross and Bevan, and Unger and Jaeger did by far the most work on this subject.

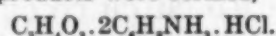
Furfural condenses with acetophenone (165) to form furfural-acetophenone, $\text{C}_6\text{H}_5\text{O.CH:CH.CO.C}_6\text{H}_5$, and furfuryl-di-acetophenone



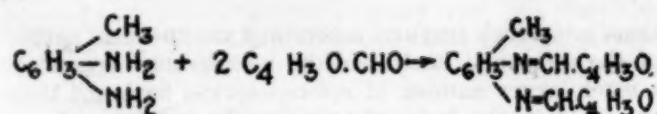
Benzylcyanide (167) condenses with furfural to form α -phenylfurfuracrylonitrile, $\text{C}_6\text{H}_5\text{O.CH:C(C}_6\text{H}_5\text{)(CN)}$, which is easily reduced forming



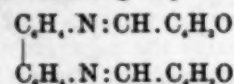
By far the greatest amount of work has been done on the reaction of furfural with the amines and related compounds because of the possibility of developing dyes. As early as 1870, Stenhouse (203) prepared the compound of furfural with aniline and various acids, finding that additional products were formed,



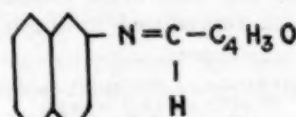
Toluidine behaved in similar manner. H. Schiff (175) supports Stenhouse's reaction and further shows that diphenylamine and *m*-nitraniline react in similar way, forming addition products. However, monomethyl-diamino-benzene follows the regular aldehyde reaction.



Benzidine reacts in similar manner, condensation taking place with both amino groups forming

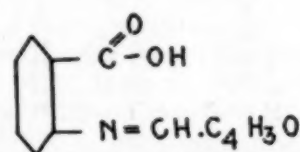


G. de Chalmot (168), however, claims that the reaction of furfural with aniline is a true condensation, the reaction taking place according to the aldehyde-amine condensation reaction. Schiff (170) also studied the action of furfural on various other amines, diamines, tri-amines, as well as acid amines, forming compounds such as



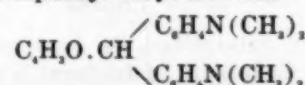
β -furfuronaphtylamine

and

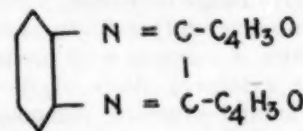


o-furfuramidobenzoic acid

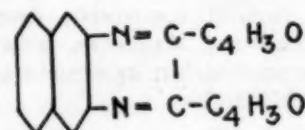
O. Fischer (180) and Schiff (177) studied the analogous reaction to the preparation of malachite green from benzaldehyde and dimethyl aniline forming tetramethyl-diamino-diphenyl-furyl-methane



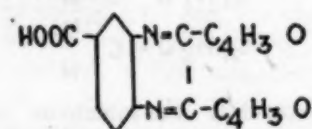
This compound on oxidation forms a dye analogous to malachite green. This reaction has recently been more thoroughly investigated by Renshaw and Naylor and a very satisfactory dyestuff obtained. Fischer (181) also studied the reaction of furoin on *o*-phenyldiamine and α - β -naphthylendiamine forming



and



Zehra (182) prepared a similar compound from 1:2 diamino 4 benzoic acid



Many others have investigated reactions of this type, forming many color bases.

It is interesting to note that in spite of the large amount of work done on the chemistry of furfural that

no study has been made of the nature of the chemical reaction taking place in the formation of resinous condensation products.

PHYSIOLOGICAL ACTION OF FURFURAL

But little work has been done on the toxicity or the general physiological action of furfural. Jaff and Cohn (118) studied the metabolism of furfural in dogs, rabbits and hens, and isolated from the excreta considerable amounts of pyromucic acid, a compound of pyromucic acid with glycocoll which they called pyromycuric acid, and a substance difficultly soluble in water which proved to be a glycocoll compound with furfuracrylic acid. Mention is made of the toxic effect, but no specific data are given.

Hugh McGuigan, of the University of Illinois, College of Medicine, has recently finished an investigation on the action of furfural on bacteria, yeast, gold fish, frogs, white mice, rabbits, cats and dogs. The results of this investigation will be published shortly in the *Journal of Pharmacology & Experimental Therapeutics*. Dr. McGuigan has kindly communicated to us the results obtained, which briefly are as follows:

1. The phenol coefficient of furfural, measured from its bactericidal action, is 0.26.

2. A 2 per cent solution of furfural entirely inhibits the action of yeast on dextrose. A 1 per cent solution only delays this fermentation. Weaker solutions have no effect.

3. Furfural is about one-half as toxic for gold fish as phenol and about one-third as toxic as formaldehyde for the same animal.

4. Furfural in large doses has a paralytic effect on frogs similar to chloral. There are evidences of stimulation of the central nervous system when smaller doses are used, but this is more marked in cats. Locally it is corrosive and anesthetic.

5. The fatal dose by stomach for rabbits is about 0.8 c.c. per kg. of body weight. The action on white mice is similar to that on rabbits.

6. In the case of cats, 0.12 c.c. is the fatal dose and with dogs the action is similar.

Part II of this paper, describing the varied uses of furfural and including a complete bibliography on the subject, will appear in Chemical & Metallurgical Engineering for Aug. 23, 1922.

Legal Notes

BY WELLINGTON GUSTIN

Buyer of Patented Welder Recovers Expense of Infringement Suit

In an action at law brought by the Lalance & Grosjean Manufacturing Co. against Neil Macneale and others, directors of the Toledo Electric Welder Co., judgment of the District Court in favor of plaintiff has been affirmed by the United States Circuit Court of Appeals. (276 Federal, 491.)

The action arose from the following transaction. In 1915 the Toledo Electric Welder Co. sold the Lalance & Grosjean Manufacturing Co. three spot welding machines of different sizes and specifications under the following terms and conditions:

The company agrees that it shall, at its own expense, defend any suits that may be instituted by any party against the purchaser for alleged infringement of any electrical or mechanical patents relating to the machinery furnished under this proposal, providing the purchaser shall have made all payments then due therein and gives to the company immediate notice in writing of the institution of such suits, and permits the company, through its counsel, to defend the same, and give all needed information, assistance and authority to enable the company to so do, and thereupon in case of final award of damages in such suit the company will pay such award." Afterward, in 1917, the American Electric Welding Co. and the Thompson Electric Welding Co. filed a bill of complaint in the U. S. District Court against the Lalance & Grosjean Manufacturing Co. for the infringement of the Harmatta patent, No. 1,046,066, and the latter company was forced to pay \$6,572 in defending this suit. The present action was brought to recover of defendants this amount, and also sought to recover in this same action money expended by it in defense of an action brought by the American Welding

Co. against the Jordan Marsh Co. of Boston, Mass., one of its customers, for a like infringement; but the District Court held it not entitled, under the terms and conditions of its written contract, to recover the expense of that suit, and it made no appeal from this minor decision.

Although defendants were given notice of the infringement suit over the Harmatta patent, they neglected and failed to defend as per the agreement, and plaintiff was forced to defend. In this action to recover their costs and expenses of defending the suit, the defendants contended as a defense that the machines sold were adapted to other uses which did not infringe the patent sued on; and further that the suit was based on the product of the machines and not on the machines themselves; and still further that the suit was dismissed on objections to jurisdiction and not on the merits.

But the Court of Appeals has held that none of these propositions is a good defense under the provision of the contract as above set out. The contract does not call for defending suits for actual infringement only, but for "alleged infringement."

Another feature in this action was the fact that the Toledo company had been dissolved and its assets had been distributed to the stockholders. The defendant directors contended that they had no money of the company at their disposal to pay the expense of such defense in the infringement suit. Nevertheless, the court said that as directors of the Toledo company at the time that corporation was dissolved the said directors became and were trustees, not only for its stockholders but for creditors, of the assets coming into their hands as such directors. If they distributed these assets to its stockholders before the payment of its creditors or the performance of the obligations of its contracts, they did so at their own risk, and accordingly were held personally liable in this action. They knew or ought to have known that it was the duty of the company under its contracts to defend and pay damages awarded and, being in control of the corporate assets, they should have applied same to this purpose.

Manufacture of Printing-Inks

BY TAYLOR W. ANSTEAD

Dry Color Department, Ault & Wiborg Co.



PRINTING-INK may be said to consist primarily of varnish and pigment, together with a considerable measure of applied research and technical experience. These factors are intimately related, since the quality and properties of the finished ink are largely determined by the fineness, shade, strength and body of the raw materials. Although actual manufacturing experience has shown that for efficient production the varnish, pigment and ink-making should be conducted in separate departments, it is nevertheless essential that the efforts of these departments be closely co-ordinated and frequent consultation should be held, in order that the varnish and pigment makers thoroughly understand and properly interpret the requirements of the ink manufacturer.

It will not be possible within the limits of the present article to present an exhaustive treatment of all of the manufacturing requirements of the printing-ink industry. An effort will be made, however, to refer briefly to those phases of its technology of most interest to the chemist and chemical engineer and to indicate the line along which the industry is developing. This treatment naturally falls under three heads, namely, varnish, pigment and finished printing-ink.

PRINTING-INK VARNISHES

The manufacture of varnishes for ink-making involves but few features that are not common to the varnish industry. From the chemical viewpoint, a deal of interest attaches to the various varnish oils, principal among which are linseed, chinawood oil or tung oil, soya bean oil, rosin oil, perilla oil and various mineral oils. Linseed oil is by far the most important for varnish making, because of its superior drying qualities, the ease with which it can be "bodied" or "heavied," the better working qualities it gives to the ink, and its good color and pleasant odor.

Many procedures have been outlined by various authorities for determining the quality of linseed oil by means of its specific gravity, iodine number, acid number, etc. But it has been found through practice that these figures are not worth much to the ink maker, and their determination is scarcely worth his while. The writer has found it most satisfactory to make varnish in the laboratory by a standard method and then to test the finished varnish for the properties required of it. Exposure in a drying oven for 2 hours gives its drying value. The varnish should have "flow"

and not be "livery"; that is, it should follow the finger after it is dipped into the varnish and not be jelly-like. The oil should give a varnish of clear color, with a pleasant odor, and free from sediment.

Chinawood oil has but a very limited application in the printing-ink industry. Its use is confined to applications in which unusually rapid drying is essential.

Soya bean oil has come to be regarded as an important substitute for linseed oil in certain of the industry's requirements. It is used either alone or in mixtures with linseed oil, especially at times when the price of linseed oil is exceedingly high. Although it is the best of the semi-drying oils, it cannot be said to be as satisfactory as linseed as a varnish oil.

Only recently has perilla oil become a factor in the ink industry. It is imported from China, is practically odorless and has a good color. It has most of the good qualities of linseed oil, as far as drying and thickening are concerned. The great disadvantage to its use has been the fact that shipments are not uniform in character and therefore the quality of the oil is not absolutely dependable.

Rosin oil is obtained by the destructive distillation of ordinary rosin and is marketed as first, second, third and fourth run rosin oil. The oil ordinarily used for varnish-making is the first run. Varnishes made from it cannot, of course, be used on bright pigments, but rosin oil makes excellent varnishes for black inks, especially when treated to obtain drying qualities.

Mineral oils of various kinds are used as varnishes in very cheap inks where a porous paper stock is used. They also find application as thinners in higher-grade inks in connection with rosin and linseed oils.

TREATING THE OILS

Linseed oil, as such, when ground with a pigment would give a sloppy ink; it must therefore be thickened or bodied to give an ink of satisfactory working qualities. The raw linseed oil, which has about the fluidity of water, can be bodied through various intermediate stages to the consistency of molasses taffy. The various bodies are numbered as a rule from a 0000 for the lightest to No. 7 for the heaviest of the boiled or blown oils. In the boiling process the linseed oil is heated in a copper kettle over a gas, coal or oil fire, the temperature and time varying with the grade to be produced.

In blowing linseed oil, air is bubbled through the oil

until the desired body is obtained. The advantage claimed for blown oils is a lower acid value and therefore better drying qualities. However, this better drying is offset by the fact that blown oils do not mix as easily with other oils and varnishes, the color is not so good, and they will not lithograph as well as the varnishes made by external heating.

In making rosin-oil varnishes, the first run oil is used because it is of a heavier body at the start and the varnishes made from it have greater drying qualities. Rosin oil is heated and then about 1 per cent of its free rosin acids are neutralized with lime. If more is neutralized the varnish dries too rapidly and is likely to form an oxidized film or skin. A more uniform drying can be obtained by adding a small quantity of some drier such for example as about 2 per cent of lead and manganese resinates.

DRIERS AND RETARDERS

A drier, it will be recalled, is a substance which when added to a varnish acts as an oxygen carrier and thus accelerates the oxidation of the varnish and causes it to dry. The action of these driers is purely catalytic.

In contrast to the driers there are substances which act as negative catalysts and actually prevent drying. Among these the most notable is selenium, the presence of a small amount of which retards drying to an extent out of all proportion to the quantity present. Recent experiments would seem to indicate that to a lesser extent the presence of sulphur in carbon blacks will retard their drying. Blacks which are free from sulphur dry much more readily than blacks which contain that element. It is a well-known fact that pigments made from basic dyes are notoriously poor driers and excess drier has to be added to the inks.

The driers in most common use are the linoleate, resinate and tungate of lead, the borate and resinate of manganese, and the acetate and resinate of cobalt. The drying effects of vanadium compounds, especially ammonium vanadate, have been referred to in a recent article by Rhodes and Chen¹, but their activity has been placed below that of cobalt. Furthermore their cost at present is prohibitive.

Each metallic drier may be said to have a different use depending upon its drying qualities. Cobalt is the best drier. Its action is to dry quickly on the surface, giving a hard film. It is surprising how small a quantity of cobalt, calculated as the metal, is necessary. One hundredth of one per cent will often dry an ink satisfactorily. Manganese dries peculiarly in that the ink remains raw for some time and then suddenly hardens. Lead dries gradually and ink in which it is used is inclined to be rather sticky. Manganese and lead together, however, will give a well-balanced drying effect.

Few people realize that the drying of an ink is not independent of the paper stock on which the ink is to be used. The oxidation which occurs is not only affected by the metallic driers but also, either positively or negatively, by the fillers and pigments used in making the paper. Too often the ink-maker is kept in ignorance of the kind of paper on which his ink is to be used. He tries to meet an average condition and frequently has his ink returned because it has not dried properly, when the fault lies in the paper.

Ink Pigments

In the manufacture of printing-inks two general classes of pigments are used (exclusive of carbon blacks)—namely, the natural or earth colors and the artificial colors. To the former class belong the ochres, umbers and siennas; to the latter class, the organic lakes, the chrome yellows and the iron blues.

The natural colors are noted for their fastness to light and for their resistance to alkalis, acids and bleaches. However, they are not easily worked, do not cover well, have a tendency to fill up the plates, and have little tinctorial value. On the other hand, the manufactured colors yield an infinite variety of shades, have great color strength and work well in varnish. Many of them, too, are comparatively fast to light and to the action of acids and alkalis.

ORGANIC COLOR LAKES

In making an organic lake the manufacturer attempts to render the dye as insoluble as possible. This is done by treating the soluble dye with barium or calcium chloride, thereby forming the barium or calcium lakes of the dye, which in nearly all cases are insoluble. Or in place of the soluble dye an insoluble product may be formed by the combination of intermediates such as the formation of the para reds by the coupling of diazotized paranitraniline with betanaphthol.

Most organic lakes have too high a tinctorial value to be used as such. Besides, they do not give as good working qualities as when diluted with an inert base. The 100 per cent color lakes are known as toners and the diluted colors are referred to in terms of the percentage of pure color present.

BASES FOR COLOR LAKES

The usual bases for printing-ink colors are blanc-fixe, aluminum hydrate or a mixture of the two. Blanc-fixe is used as the base for the cheaper colors designed for poster or bag inks. The artificial barium is preferred to the naturally occurring barytes, which is very rarely used in printing-inks because it is gritty. Blanc-fixe is of two kinds, the precipitated and the byproduct material. Experience has shown that the byproduct blanc-fixe is usually unsuited for lithographic inks because of its action with water. The ink from such a lake becomes pasty because of its water absorption or, in exaggerated cases, it may literally "go to pieces" and break down entirely. Precipitated blanc-fixe should be white, neutral and free from sulphides. Sulphides very often give trouble in connection with copper plates or when the blanc-fixe is mixed with a lead chromate yellow.

Aluminum hydrate is very transparent and is therefore suitable for process inks where one color must be seen through the color above it. Great care must be exercised in the manufacture of aluminum hydrate for color lakes. It is ordinarily prepared from aluminum sulphate and soda ash. The former should be free from iron, since ferric hydroxide gives the aluminum hydrate a dirty, brownish color. Precipitation is best effected in dilute solutions, 10 per cent or less, because too great a concentration is likely to give a product which dries out too much. The base should be carefully washed to free it from soluble sulphates, as these are likely to give trouble in lakes precipitated with barium chloride where the presence of barium sulphate would throw the color toward the semi-transparent

¹F. H. Rhodes and K. I. Chen, *J. Ind. Eng. Chem.*, vol. 14, pp. 222-4 (1922).

side. The writer has observed batches of color made from the barium lake of lithol red where the addition of poorly washed aluminum hydrate has caused the lake to lose its bluish shade and take on a yellower shade due to the barium leaving the dye and combining with the free sulphate in the hydrate.

A base which is quite popular is a mixture of blanc-fixe and aluminum hydrate. In this base, the advantage of the comparatively low cost of the blanc-fixe is combined with the high finish and luster given by the aluminum hydrate.

PARA AND TOLUIDINE REDS

The red organic lakes present the greatest variation in color from the yellow-red, almost orange shade, of a light para red to the deep blue shade of the eosines. The good old standby of the ink-maker, as of the paint-maker, is paranitraniline red. The light shade is produced by combining diazotized paranitraniline with beta-naphthol. The deep shade is produced—and here is one of Nature's mysteries—by the addition of about 5 per cent of beta-naphthol monosulphonic acid F to the beta. Paranitraniline gives nothing like the same shade with F acid alone; the shade results only when the color is heated and furthermore, the addition of too much F acid is likely to throw the color over to the brown side and cause it to lose its blue tone entirely.

The para reds are popular because of their good working qualities, the comparatively low cost of the intermediates entering into their production, their relative fastness to light and to the action of acids and alkalis.

A color of even greater permanency is toluidine red from diazotized meta-nitro-paratoluidine and beta-naphthol. The cost of the former intermediate makes its use not quite so common. An interesting incident grew out of the attempts of the writer to improve upon the quality of the post-war toluidine reds. The laboratory results were fine and bright and so too were the results on the semi-plant scale tests, but the first four or five large plant batches were miserable failures. Temperatures were checked, dilutions were checked, materials were checked, but to no avail. Finally the only difference that could be seen was that lead brine coils were being used to cool the diazo solution, whereas ice had been used in the laboratory and the semi-plant operation. In the next run ice was therefore used and the diazotization was carried on in a vat free from lead. The results were all that could be desired.

LITHOL REDS AND EOSINE LAKES

Next color in importance to the toluidine reds are the lakes made from lithol red, which is a combination of Tobias acid (2-naphthylamine—1-sulphonic acid) with betanaphthol. The sodium salt is used alone or diluted with white to give a yellowish red; when the sodium salt is boiled with barium chloride a bluer shade results. Treatment with calcium chloride produces a very deep, bluish red. An interesting fact to be noted in connection with the lithol colors is that the calcium lake will stand baking, whereas the sodium and barium lakes will not. In purchasing the dye, care must be taken to see that it does not give lakes which "bleed" in oil. This bleeding is due to the presence of beta-naphthylamine arising from the use of impure Tobias acid. Lithol reds now appearing on the market as a rule are free from this objectionable

feature. This oil-bleeding is a serious defect in fine printing because the color will strike through with the oil and can be seen to stain the reverse side of the paper.

Eosine lakes are used to a considerable extent in process work where a very pure red of bluish hue is desired. The lakes can be prepared from eosine by precipitation with lead nitrate or lead acetate, but it is more economical to prepare them from the bromo acids. Eosine is the sodium salt of tetrabromofluorescein, whereas the bromo acid is the acid of the same compound. If the acid is used it is first dissolved in alkali and then re-precipitated as the lead salt. Experience has shown that greater strength is to be had from the bromo acid than from the corresponding eosine. Bromo acids are to be had in two classes, the boiling bromos which are precipitated and boiled and the non-boiling bromos which are struck at lower temperatures. The first class gives a bronze red while the second class gives a red of dark overtone and more transparency.

These are the main divisions of the reds, though many others might be named. In fact, a well-equipped printing-ink concern uses 20 to 25 different red pigments. Unfortunately it seems to be a rule with red pigments that the stronger and brighter the color the less permanent it is to light. For instance, the bright, clean eosine and rhodamine lakes are very fugitive with light, whereas the duller para reds and madder lake are comparatively permanent.

BLUE PIGMENTS

The blue pigments used in the greatest quantity are the so-called iron blues. They vary in shade from a greenish blue to the blue of a reddish, almost purplish, cast. Before 1914 nearly all the blues were made from potassium ferrocyanide, either alone or in combination with sodium ferrocyanide. The impression existed in pre-war days that good blues could not be made from prussiate of soda. However, that impression was speedily removed from necessity when the supply of potash was cut off and it was not long before the American dry-color maker learned that very good blues could be made from prussiate of soda. Even now when prussiate of potash is available, the soda blues have not lost their popularity.

Ultramarine blue, another pigment of great utility because of its cheapness and resistance to alkali, has reached a perfection in this country never known before, even among the products of the best of the European makers.

The only blue lake used to any great extent is peacock blue, the barium lake of patent blue. This is used largely in process inks on account of its pure blue tone. The peacock blues of war times and post-war times were not very satisfactory.

The product was helped some by imported dyes, but now the American manufacturers are making very good patent blue.

OTHER INK PIGMENTS

The yellow pigments in greatest demand are the chrome yellows made from sodium bichromate and lead acetate. To a basic lead acetate solution is added a bichromate solution containing sulphuric acid. The lead chromate formed varies all the way from a light lemon yellow to an orange depending on their reaction.

The light yellows show an acid reaction, the medium yellows are practically neutral lead chromate, while the orange yellows are made by boiling the precipitated lead chromate with caustic soda or soda ash, thereby forming the basic lead chromate.

Yellow lakes from the barium precipitation of acid yellow dyes are used where a transparent yellow is desired in contrast to the opaque chrome yellows.

Most of the purples and violets are made from methyl violet which can be had in a great variety of shades from the very red (R) to the very blue (6 B). Where brilliancy of color and no great amount of permanency are required, the usual method is to precipitate the methyl violet with tannic acid and tartar emetic. However, under patents now licensed by the Chemical Foundation, violet lakes may be produced from methyl violet by precipitation with sodium tungstate or with phosphotungstic acid. This increases the permanency of the violet lakes to a remarkable degree and raises them from the "fugitive" to the "semi-permanent" class. The peculiar thing about the lakes so produced is that when acted upon by light they turn darker. This increased permanency may be extended to some of the other basic dyes like fuchsine, malachite green, and Victoria blue, but the lakes of these dyes have not the variety of application that the purple lakes have.

MANUFACTURING KINKS

In the manufacture of pigments a good washing is necessary because the salts formed on drying down with the pigment not only reduce the strength but are likely to affect the ink, especially when intended for lithographic purposes where the action of the salts with the water may destroy the working qualities of the ink. Drying must be watched closely in pigment making.

Some colors are very readily affected by heat and it is better in most cases to dry for a longer time at a low temperature than to heat too high in order to speed up drying. About 160 deg. F. is a very good temperature for the drying ovens. The general scheme is to draw air through coils heated by steam. This heated air then passes over the color, which is in thin cakes on drying racks. Exhaust steam from the boilers can be used to good advantage here.

When dried, the color is ground. The finer the color, up to certain limits, the better it can be ground on the ink mill with varnish. About 60 to 80 mesh is the proper fineness. Finer than 80 mesh makes the color too fluffy and causes a great deal of dust and waste. In order to get uniformity the color is ground into large mixers holding 2,000 lb. or more. It can then be strengthened if weak, or cut down if too strong. As a rule a composite of several batches of pigment are mixed at one time, as it is practically impossible to make every batch of pigment identical and this method strikes a good average. Standards for comparison purposes should be taken the same way. Too often the enthusiastic color man, on seeing a remarkably fine batch come through the factory, adopts it as the standard, sends out samples and then has tough sledding to duplicate it, whereas if he had taken an average of eight or ten factory batches he would be nearer the true standard. Another dangerous practice is to send out samples of laboratory lots before they have been duplicated in the plant.

The improvement the last two years in the quality

of the dyes and pigments produced in this country has been remarkable. Old standards adopted during the war look dull and muddy by contrast with colors produced with improved dyes and intermediates. Along with the improvement in colors has come an increased discrimination upon the part of the printer and color user.

Ink Manufacture

After the varnish and pigments have been prepared they are sent to the mixing room. Here they are weighed into mixing cans and the color is thoroughly wet with the varnish on a pony mixer. This is a machine so geared that the can turns in one direction while four prongs, dipping into the mixture, turn in the opposite direction. The ink is then sent to the mill room, where it is run over the ink mill. This mill is composed of three steel rollers with carefully ground surfaces, set in a frame. The rolls are usually 9 or 12 inches in diameter. Their highly polished surfaces roll in contact with each other. The ink is fed into the rear roller, which rotates clockwise, and is ground between it and the middle roller, which moves in a counter-clockwise direction. The ink is taken from the front roller by means of the knife-edge of the apron, which fits tightly against the roller. (See illustration.) A great deal of heat is generated during grinding and the rollers are made hollow so that cooling water can be passed through them. Many colors change on grinding if the rolls are not so cooled. The light shade of paranitraniline red will develop quite a bluish shade on grinding or may even turn brown if too much heat is developed.

PROVING AND TESTING

The number of runs through the mill which an ink requires is determined by the pigment. Some colors, like the chrome yellows, are ground in three runs, while the iron blues will often take five or six. The question of determining whether or not an ink is properly ground is largely a matter of experience. An experienced ink-maker can tell by rubbing the ink about under his fingers. Spreading the ink out under a spatula will often show up particles of grit.

As the last run of the ink is coming out of the mill, a small sample is sent to the testing department, where it is drawn down on a sheet of paper against the standard to get the overtone, or mass-tone, and the undertone, or shade. A small portion is then carefully weighed out with an opaque white mixing ink in the proportion of 10 of white to 1 of color; the standard is treated in the same way. This test shows the tinctorial or coloring power of the ink and gives a very good way to determine any fine differences in the shade, since slight variations are easily discernible in the bleach test.

It has been found by experience that whenever possible it is best at this point to make a proof of the lot of ink and of the standard and allow them to stand over night to notice the effect of drying. Any change in shade will likewise be noticed. The body of ink should be examined the following morning, as often an ink will appear to have the right body when warm from grinding, but on cooling over night may become too heavy or may "liver up." A case was recently called to the writer's attention where a green made from an iron blue and a chrome yellow had changed to a decidedly yellow tone over night due to the action of

the paper on the blue. The remedy was to make the pigment several shades bluer.

PRINTING REQUIREMENTS

Printing ink is put to such a variety of uses that the ink-maker must use a great deal of discrimination in the choice of his pigments and varnishes, but most especially of the former. For instance, an ink may be wanted for a hand-press, for a flat-bed press, for a rotary press, for offset work, for a bread label, soap wrapper, butter wrapper, poster, bag or bottle. Each use calls for a different body and drying quality of ink and in addition, the coloring matter must have certain properties. One color may be permanent enough for a circus poster but might bleed in hot paraffine and therefore be unsuitable for a bread label, or the color might make a beautiful ink for an art calendar or a book illustration but be utterly useless on a soap wrapper.

The question of fastness to light is of vital importance in many cases. It is a sad day for the billboard advertiser if the ink maker has been careless in the choice of his pigments and after three or four days his advertisements have bleached out or changed color decidedly. Of course, the best test for permanency to weather conditions is to put the color on a billboard for a period of one month. Often quicker tests must be had and resort is made to artificial devices. One of the best of these consists of a constant-arc light surrounded by a metal cylinder containing openings and brackets on which the colors to be tested are exposed. One half of the sheet is kept covered and one half exposed. A pan of water acts as a humidifier and with the aid of a fan, which draws a current of air through the apparatus, prevents baking. To simulate atmospheric conditions the proofs are wet every morning. Proofs are left under the light for a time depending upon the conditions which must be met. One hour under this light equals six hours of sunlight. Sometimes a qualitative test of colors to determine the dye used can be made by this exposure test. For instance, a malachite green lake can be distinguished from an acid green lake by the fact that lakes from the former dye turn darker under light, while lakes from the acid green fade out entirely.

THREE CLASSES OF PRINTING-INKS

Printing-inks may be divided roughly into three classes: typographic, lithographic, and depressed surface inks. Typographic inks include all inks for labels, catalog and book work and general job-printing. The inks of this class are much softer and thinner in body than the lithographic inks and in the preparation of them, pigments can be used which "bleed" in water.

Lithographic inks are heavy in body. They are used in the presence of water and therefore must be water resistant. Accordingly great care must be exercised in the selection of varnishes and pigments. Inks which absorb water and become short and greasy are worthless for lithographic work, as they tend to smear and do not give clear-cut impressions. An ink which when rubbed with water on the lithographer's stone becomes pasty or stringy is unfit for use as a lithographic ink.

Depressed surface or plate inks are used for copper-plate engraving, for calling and announcement cards, in making season and greeting cards, and similar examples of fine printing. One kind of ink which can

probably be classed under depressed surface ink is rotogravure ink. This type of work, wherein a half-tone effect can be had on machine finish paper, was just coming into prominence before the war. The demand for illustrated material brought this process into great favor as evidenced by the fact that today nearly every large newspaper carries a weekly rotogravure supplement. In this process the design to be reproduced is etched on copper cylinders. These cylinders dip down into the ink and are wiped off by a steel blade, leaving the ink in the depressed surfaces while the high lights have no ink on them. The paper is then passed over the cylinder, and after running about 25 feet, the reverse side is printed. Hence for this type of work ink must be a rapidly drying one.

The highest grade ink of all is the process ink. In this work, three, four and sometimes more colors are superposed upon one another. The colors used in four-color work are yellow, red, blue and black, printed in the order named. Each color except the yellow must be transparent or semi-transparent to get the effects of the colors beneath it. In this way, reproductions of painting are made. A separate plate is made for each color by photographing the painting four times. Each time only the color value desired is photographed, the others being kept out by suitable light filters. Colors like green, orange, violet, etc., are formed by combinations of the four principal colors. For instance, blue over yellow gives a green; or a dark purple would be produced by blue over red intensified by black, and so on. The colors entering into these inks are of very pure tone and must be of fine grain, otherwise the cuts would be filled up and ragged outlines result. Only the very highest grade linseed-oil varnishes are used in process inks.

The one universal ink is black. There are innumerable kinds of black inks. Blacks which dry by penetration may be made from cheap carbon blacks and mineral oil. Rotary blacks for process work, which dry by oxidation, are made from very good rosin-oil varnishes or linseed-oil varnishes.

NEW DEVELOPMENTS

New developments in printing machinery must be met by the ink-maker. One of the latest improvements is a press doing what is called simultaneous color-printing, that is, three colors are printed, one on top of the other, before the sheet leaves the press. The ink manufacturer is also called upon to meet new conditions arising from change of paper stock or method of working. The printer makes his changes to suit his customer or his purse and then tells the ink-maker to get busy and make an ink to fit his requirements.

It may be seen from this rather cursory review of the materials and manufacture of printing-ink that physics plays as important a part as chemistry. The chemistry of ink-making is comparatively simple even in pigment manufacture, whereas the physical side of the process presents infinite possibilities. Colloidal chemistry, however, is beginning to play an important part in ink-making and many of the ink-maker's difficulties will probably be overcome as our knowledge in this field increases.

Constant research supplemented by the accumulated experience of the ink-maker is the price to be paid for this industry's success.

Cincinnati, Ohio.

Effect of Rate of Loading On Tensile Properties Of Boiler Plate

BY H. J. FRENCH

Physicist, Division of Metallurgy, Bureau of Standards

WHETHER or not steel is susceptible to variations in rate of loading at operating temperatures of steam superheaters, crude oil stills or nitrogen fixation apparatus is of decided interest both from practical and theoretical standpoints, especially as there are comparatively little definite data available in the literature.

In his book on "The Manufacture of Iron and Steel," H. H. Campbell reports the tensile properties of structural steel obtained under pulling speeds of 0.07 to 4.5 in. per minute. Both the yield point and tensile strength were shown to increase with rate of loading, while the elongation and reduction of area remained practically constant. The last two are independent of the accuracy of the beam balance; when high pulling speeds are used it becomes increasingly difficult for the operator properly to balance the testing machine and the tendency toward "overbalancing" often results in high values.

A committee of the American Society for Testing Materials¹ has since shown that the tensile properties of steels at room temperature are independent of the rate of extension within limits of commercial practice—speeds of from 1 to 6 in. per minute.

HOT STEEL RESISTS RAPID LOADING

Little exact information is available on variations in speed of loading at elevated temperatures. Hopkinson and Rogers² reported that the so-called "time effect," "elastische nachwirkung" or "creeping" increased greatly with temperature. While such effects might be detected at ordinary temperatures, they attained a different order of magnitude at red heat (600 deg. C.).

"Creeping" made the determination of Young's modulus a matter of some uncertainty, for the extension of a bar stressed at 600 deg. C. varied 15 per cent or more depending upon the time of application of the load. For rapid loadings—of the order of 1 second—the strain produced approached a definite limiting value which could be used for the accurate determination of the modulus.

J. E. Howard³ reported that the "rate of speed of testing, which might modify the results somewhat with ductile material at atmospheric temperature, had a very decided influence upon the apparent tenacity at high temperature." Steel containing 0.81 per cent carbon was ruptured in 5 to 10 minutes and also as quickly as from 2 to 8 seconds. Nearly the same strength was displayed whether slowly or rapidly fractured at temperatures below about 315 deg. C. (600 deg. F.), this being a comparatively brittle metal at moderate temperatures. Above this temperature the apparent strength of the rapidly loaded specimens largely ex-

ceeded that of the slowly loaded ones; the higher the temperature the wider the spread. One specimen broken in 2 seconds at 766 deg. C. (1,412 deg. F.) showed a tensile strength of approximately 62,000 lb. per square inch, whereas at ordinary speed of testing a corresponding bar fractured at 33,240.

Howard considered that the forces of cohesion tending to prevent rupture in a plane normal or oblique to the direction of the straining force and intermolecular friction developed during the flow of the metal were controlling elements in the explanation of the behavior of steel under the conditions outlined.

More recently Rosenhain and Humfrey⁴ have investigated the strength and fracture of soft steel at temperatures between about 600 and 1,100 deg. C. (1,100 and 2,000 deg. F.). They found a discontinuity at the thermal critical range and an increased tenacity with rapid loading when testing small samples in a vacuum.

APPARATUS FOR RAPID TESTING

The ordinary method of determining proportional limit by measuring the deformation under successive increases in load is not sufficiently flexible to allow much variation in rate of extension without loss of accuracy. Obviously, it is impossible to read simultaneously several continuously moving indicators, even with a number of observers. Therefore an ordinary testing machine was modified in some essential details so that instruments indicating stress and strain were placed close together where they could be photographed during the test by a motion picture camera. This arrangement has already been described in *Chemical & Metallurgical Engineering* for Jan. 19, 1921 (vol. 24, p. 131).

Load may be applied at any predetermined rate, and while the beam was at all times kept as nearly in balance as possible by the operator, photographs were taken of the three constantly moving dials at the rate of about one a second. The loading was continuous until the bar was broken and no changes in gears or

⁴J. Iron and Steel Inst., vol. 87, p. 238 (1913).

TABLE I—HOT-ROLLED BOILER PLATE, LOADED AT VARIOUS RATES

Temp. of Test, Deg. C.	Motion Of Grips, In. Per Min.	Proportional Limit, Lb. Per Sq. In.	Tensile Strength, Lb. Per Sq. In.	Elongation In 2-In. Per Cent	Reduction In Area, Per Cent	No. of Tests Averaged
21	0.05	25,000	35,500	43.5	66.2	1
21	0.51	27,050	55,850	43.7	65.5	3
21	0.80	26,000	56,700	43.8	64.3	2
21	1.63	27,100	56,400	42.8	64.8	2
156	0.05	26,000	58,400	35.3	55.4	1
156	0.51	27,600	62,050	25.8	54.7	5
156	0.80	26,000	63,700	29.0	53.8	2
156	1.63	25,650	51,200	27.8	56.0	4
295	0.05	18,400	63,600	33.3	58.9	1
295	0.51	19,250	64,750	30.1	53.8	3
295	0.80	19,350	61,350	31.7	57.8	6
295	1.63	18,750	65,100	30.5	51.9	6
463	0.05	13,800	34,700	42.2	74.3	5
463	0.51	10,600	38,600	41.8	74.9	4
463	0.80	15,100	37,900	43.2	75.0	4
463	1.63	15,800	40,750	41.1	73.0	3

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¹Proceedings, vol. 6, p. 109 (1906).

²Proc., Royal Society of London, vol. 76, p. 419 (1905).

³Iron Age, vol. 45, p. 585 (1890).

TABLE II—EFFECT OF SLOW LOADING ON THE TENSILE PROPERTIES OF FIREBOX BOILER PLATE

Temp. of Test		Rate of Loading	Prop. Limit, Lb. Per Sq. In.	Tens. Str., Lb. Per Sq. In.	Per Cent Elong. In 2 In.	Per Cent Red. Of Area	Remarks
Deg. C.	Deg. F.						
156	313	Adopted standard*	26,600	58,100	24.9	49.3	Av. 3 tests
156	313	6 1/2 hr. from 22 to 47,000 lb. per sq. in.		64,350	22.8	45.9	Av. 2 tests
295	563	Adopted standard*	14,330	66,430	25.9	53.1	Av. 3 tests
295	563	3 1/2 hr. from 9 to 20,000 lb. per sq. in.		60,000	36.0	59.2	
463	865	Adopted standard*	13,200	47,460	33.6	68.5	Av. 3 tests
463	865	6 hr. from 9 to 30,000 lb. per sq. in.		33,600	42.0	78.4	

* Adopted standard averages about 0.05 in. per minute extension.

motor speed were made throughout the test. After development the film was projected on a screen, where images of the dials were enlarged and as much time as was desired might be taken in obtaining individual readings. Under the conditions outlined above more photographs were obtained than required, but these served as an indication of the balancing of the beam; if this is not closely maintained, it results in serious deflections in the resulting stress-strain diagrams.

MODERATE VARIATIONS IN RATES OF LOADING OF SMALL IMPORTANCE

A summary of the tests made on railway firebox steel at various temperatures under different rates of extension is given in Table I. The following conclusions may be drawn:

1. The tensile properties of firebox steel at temperatures up to and including the blue-heat range [295 deg. C. (565 deg. F.)] are independent of the rate of loading.
2. At 465 deg. C. (865 deg. F.) the tensile strength appears to increase slowly with rate of loading while ductility as measured by elongation and reduction of area is practically constant.

At this highest temperature the stress-strain diagrams obtained were not satisfactory. The elastic limit is low and is reached soon after the "slack" is taken up in the available geared apparatus. There is, however, a difference in behavior of the metal at or below blue-heat and 465 deg. C. (865 deg. F.) as indicated by variations in the figures for ultimate strength.

SLOW LOADING

In addition to the foregoing tests, samples of A.S.T.M. firebox plate were broken at about the same temperatures by increasing the applied stress very slowly when passing the proportional limit. The load was increased 100 lb. at 5-minute intervals over a definite range at each temperature and subsequently the test specimen was broken at standard speed. Such slow loading raises the strength and decreases ductility at 156 deg. C. (315 deg. F.), but the steel exhibits decreased strength and higher ductility when so tested at blue-heat or above than when broken in the ordinary manner. Table II contains the figures.

MICROSCOPIC EXAMINATION

Fractures of steel broken at various temperatures at different rates of loading and under varying conditions of mechanical work were examined under the microscope and were found to be generally transcrystalline. Minor differences appear under certain conditions, such as, for example, the apparent tendency for

the fracture to follow more deeply along the grain boundaries and particularly at the junctions of ferrite and pearlite when the steel is broken under very slowly increasing stress, but in general no marked differences in behavior were observed.

Tearing Tests on Metals

BY HENRY L. HEATHECOTE* AND C. G. WHINFREY†

THE results of impact tests are sometimes very surprising. A material which may give good results under the tensile test will sometimes give quite the reverse of good results under an Izod impact test. Such test-pieces break like a carrot. The simile is literal; it is not at all easy to break a carrot until the periphery has given way, then it tears across quite easily. This tearing is a point we should like to dwell upon for a few moments.

Metals in structures are figured to resist either tension or shear, and engineers speak of the working stress being so many pounds or tons per square inch. This is convenient and satisfactory so long as that square inch does what is expected of it and carries the load pretty uniformly. But the pious hope that every section will do its duty ought not to close one's eyes to the possibility that some day that whole load may be borne not by the square inch but by a very small part of it. In fact it has recently been shown by Professor Coker that heavy stress concentrations are to be expected in parts where the section changes. Then a load of so many pounds or tons per square inch will become so dislocated as to overstrain the piece badly at the surface and the material will tear.

To see this point more clearly consider the behavior of a material possessing no elongation. Such a metal might stand well under static tension and shear; but once a crack started, at the periphery for instance, it would spread right across under a vanishingly small pull for the reason that in such a material the forces at the apex of the crack would be enormously great. Of course, such material is unknown, but many are known which approximate to such a condition.

Some years ago one of us studied the failure of india rubber and observed that although it stood tension remarkably well it tore quite easily. A poor specimen required to tear it apart only 1/150 part of the energy required to pull it apart. This suggested applying a similar test to metals.

Tested in this way one gets the following results for resistance to tearing:

Thickness Tested, In.	
0.018	Tin plate, 770 to 750 lb. per linear inch.
.015	Brass, as received 651, annealed 530 lb. per linear inch.
.028	Aluminum, 270 lb. per linear inch.
.091	0.40 C steel, 1627 lb. per linear inch.
.018	0.05 C steel, 989 lb. per linear inch.
.013	Copper, 912 lb. per linear inch.
.075	Lead, 220 lb. per linear inch.

We had no difficulty in finding specimens of steel which tore at about 1,000 lb. per linear inch. The energy required to tear 1 sq.in. of such material was about one-fifth as much as to pull a piece 1 sq.in. in two.

Test-pieces for tearing tests have to be cut from thin sheets. The best form we know is made by taking a piece of sheet, about 2x4 in. in area, and slitting it carefully with tinners' snips as shown in Fig. 1. The

*Chief of Research Laboratories, Rudge-Whitworth, Ltd., Bearing Works, Birmingham, England.

†National Lamp Works of General Electric Co., Nela Park, Cleveland, Ohio.

tongue of metal 1x3 in. is turned out square out in front, and the two wings exactly opposite in direction, making a piece as shown in Fig. 2. This bent test-piece is then mounted in a tension machine, one grip taking the tongue and the other the wings. A delicate machine capable of registering accurately loads of a few pounds is required, for even the toughest steel in thickness of a few hundredths of an inch will require only 100 lb. more or less to tear it apart. A machine for testing paper or fabric will usually serve excellently.

Pull is then gradually applied until the metal tears as may be observed under a strong glass. The load is observed and immediately released. Five or six repetitions are made and the average taken for the strength of the metal.

The pull observed is that required to tear metal in two places and bend and unbend a total width equal to that of the specimen. In order to eliminate the work done in bending, it is necessary only to execute a similar test on a narrower or wider test-piece cut from the same material.

If P is the pull required to tear, bend and unbend a piece x in. wide
and p is the pull required to tear, bend and unbend a piece y in. wide
then $P - p$ is the pull required to bend a portion of the piece $2x - 2y$ in. wide

$$\text{Therefore pull required to bend } 2x \text{ in.} = \frac{P - p}{(2x - 2y)} \times 2x$$

$$2x = \frac{(P - p)x}{x - y}$$

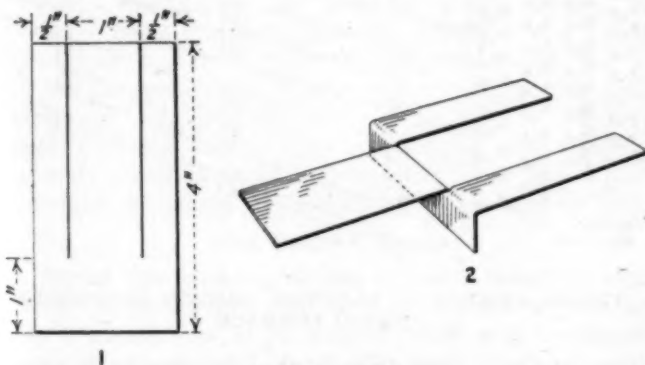
Pull required to tear specimen in two places

$$P - \frac{(P - p)x}{x - y} = \frac{px - Py}{x - y}$$

$$\text{Tearing force per linear inch} = \frac{px - Py}{2t(x - y)}$$

Where t is the thickness of the sheet.

It is apparent that the force required for bending will quite overshadow the force required for tearing in a thick piece.



FIGS. 1 AND 2

Fig. 1—Test-piece before bending.
Fig. 2—Test-piece after bending.

So far as we are aware the testing of metals for resistance to tearing is being done only at the Rudge-Whitworth research laboratory, in Birmingham, England.

The impact test on notched bars approaches the tearing test more closely than the ordinary tension test does, for the rupture of the metal in notched bar impact is by rapid tearing. By testing two specimens with different cross-sectional areas, it is possible to obtain simultaneous equations and to solve for the energy required to bend the test-piece and the energy required to tear it. In applying this method to some

tests done at the National Physical Laboratory by Dr. Stanton and Mr. Batson, the resistance to tearing of one of the steels tested is found to be 1,580 lb. per linear inch, which is in close agreement with the figure for medium steel already referred to, obtained by tearing a sheet of thin steel and measuring the pull required.

We may reasonably expect tearing tests to throw light upon the suitability of materials for constructional purposes and that they will be of interest to metallurgists in throwing light upon the physical constitution of microstructure of metals and alloys. From the appearance of the fractures which occur during the life of metals in use it is obvious that they are for the most part tear-fractures, or, as they are more commonly called, "fatigue-fractures." Indeed, "fatigue fractures" doubtless start from some internal notch where the stress concentration is above the ultimate strength of the material. Probably all hardened steels break by tearing, as also do high tensile alloy steels such as nickel-chromium steel.

On the other hand, it would not do to assume that resistance to tearing should always be as high as it is possible to make it. When material is machined the ease with which it is removed by the tool depends upon the ease with which it tears apart forward of the tool point; and a high machining speed will be obtained only when the Brinell hardness and resistance to tearing are relatively low.

Calcium Silicide as a Deoxidizer

According to a recent number of *The Iron and Coal Trades Review*, the use of calcium silicide for deoxidizing liquid steel is increasing in favor among English steel makers. This fact is due to the very powerful deoxidizing characteristics of calcium, and will, under conditions where silicon alone is not sufficiently powerful, usually completely deoxidize the metal. Calcium metal has a very powerful affinity for oxygen, and while the oxide, as well as silicon oxide, melts only at extremely high temperatures, mixtures of the two form silicate slags which melt at temperatures existing in the steel furnace. Such slags are insoluble in the metal, rise to the surface, and are easily incorporated in the normal slag, which is of the same nature.

The use of calcium as a deoxidizer under normal conditions should be quite safe, as any excess calcium left in the steel after the reaction is completed will be rapidly oxidized from external sources of oxygen in the surrounding air or volatilized, consequently there is little risk of leaving any trace of calcium in the steel.

Like silicomanganese, it is a ladle addition, and preferably made in powdered form. French alloy containing Si 60 to 65 per cent, Ca 30 to 35 per cent and Al 2 to 3 per cent is mostly used in Great Britain. It is reported that the violence of the reactions cause small explosions to take place if lump material is added to gassy steel. This phenomenon has not been noticeable in American experiments with the alloy.

Two grades are available in the United States, manufactured by the Electro Metallurgical Co. in the electric furnace:

	Grade 1	Grade 2
Ca	24 to 28	18 to 22
Si	65 to 70	55 to 60
Fe	3 to 5	15 to 20
Al	About 1	About 1

An alloy of calcium, silicon and manganese has also been recently developed by the American concern which may prove superior, in some cases, to the simple ferros.

The Technology of the Carbon-Electrode Industry—V Baking and Baking Furnaces

A Critical Study of the Baking Process as Carried Out in Electric and Gas-Fired Furnaces—A Review of the Principles Underlying Their Construction and Design—American Operating Practice—Comparative Advantages of Different Types of Furnaces*

BY CHARLES L. MANTELL

Division of Industrial Chemical Engineering, Pratt Institute, Brooklyn

BAKING in the carbon-electrode industry has for its object the conversion of a highly resistant "green" electrode into a low-resistance finished product; the conversion of a material with qualities and properties which vary with temperature changes into one whose properties remain fairly constant over a wide range of temperatures; and lastly, the conversion of a material with low tensile strength into one which is strong and capable of withstanding hard service.

Baking accomplishes these results by a distillation-cracking action on the binder. As the temperature increases the binder successively softens, melts, loses its lighter constituents by distillation, and finally is converted into coke. At the end of the baking process, even the coke has lost whatever volatile matter it may have retained during its actual formation. According to the speed of temperature rise in the process, the volatile portions of the binder may or may not be "cracked"—that is, broken down into simpler compounds and carbon. As the result of the coking of the binder, the whole mass of the electrode is held together very strongly. Each small particle that had been covered by a film of binder is bound to the adjacent particles by an extremely thin layer of coke.

The change that has taken place during baking is easily demonstrated. A green electrode, if struck on a stone or concrete floor, causes a sound much like a thud. The same electrode after baking, if struck in the same manner, gives out a resonant bell-like tone.

The furnaces used are of two kinds, those in which the heat for baking is generated by the electric current, commonly called electric furnaces; and those in which the heat for baking is obtained from the burning of a combustible gas, commonly called gas furnaces.

Electric Baking Furnaces

The rise of electrode manufacture has paralleled that of the electrochemical industries. The electrochemical industries naturally gravitated to sources of cheap power, which were the great hydro-electric developments. Electrode plants soon located near their electrochemical customers and they themselves became users of cheap power for heating purposes. As a result, during the earlier stages of the development of carbon manufacture, the electric current was used entirely for electrode baking to the exclusion of other methods of heating. Now, however, the electric baking of amorphous carbon electrodes is becoming an obsolete procedure. Its value from the point of view of the development of the electrode industry, as well as its

significance to other lines of manufacture, is believed to be sufficient to warrant its consideration in the present discussion.

The electric furnaces used for carbon baking are of the horizontal Acheson resistance type, heating the contents of the furnace by the resistance of the charge. They consist simply of two ends, which are brick walls in which the electrodes for carrying the current to the charge are supported, and two removable sidewalls of brick set up by hand without mortar or cement. The bottom of the furnace is insulated by filling it with some cheap dielectric, such as broken concrete, gravel, brickbats, etc. The appearance of the built-up furnace is that of a rectangular box. Furnaces usually are operated on single-phase alternating current at twenty-five cycles frequency with 30 to 60 volts.

The sketch in Fig. 24 shows the principal features of a standard baking furnace. Power is supplied from

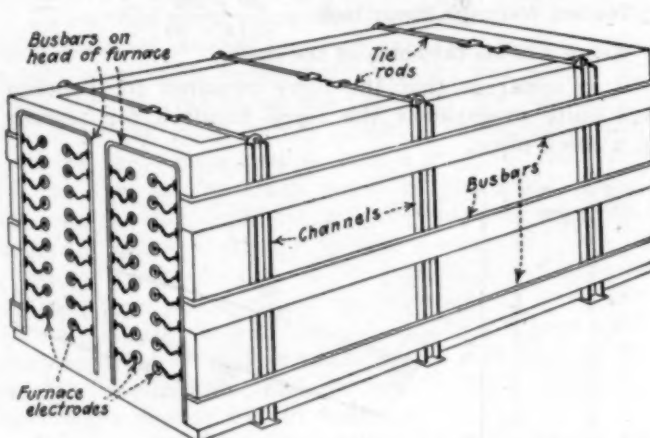


FIG. 24—SKETCH OF ELECTRIC CARBON ELECTRODE BAKING FURNACE

transformers to the furnace through copper or aluminum busbars, both heads of the furnace being connected by furnace busbars to the main set from the transformers.

DETAILS OF CONSTRUCTION

The sidewalls are of refractory clay brick, built in such a manner that the bricks in the wall "lock" one another in position by continuously crossing, layer after layer. Either one or both walls are torn down at the end of a run so that the baked carbons may be unloaded from the furnace. The sidewalls are held up and supported against undue pressure from the inside by channel irons placed at definite intervals. The ends of the furnaces are built of fireclay brick laid in place with mortar or cement.

*The preceding articles of this series were published in *Chem. & Met. Eng.*, vol. 27, Nos. 3, 4, 5 and 6.

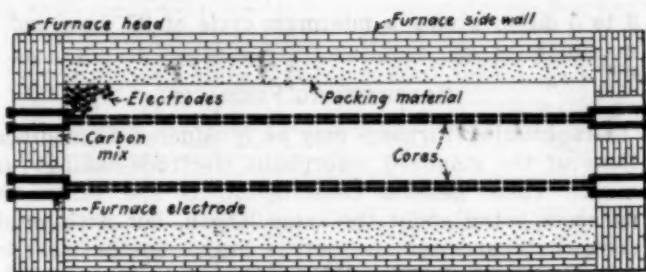


FIG. 25—PLAN OF ELECTRIC BAKING FURNACE

Transformers used are normally of the single-phase, twenty-five cycle, oil-filled type with a voltage range on the low side of 30 to 60 volts. The capacity of transformer used depends upon the size of the furnaces connected to it. Usually electrical connection is made so that four furnaces are "hooked up" to a single transformer. This is done so that the transformer may be operated at all times except when a change of connection between furnaces is being made. Switches are not provided for the furnaces, but only for the transformers. When a furnace is not "on power" (that is, not having power passing through it), the side busbars are removed so that the heads of the furnace are disconnected. Operation is such that one furnace of a group is always on power, the others are cooling, loading or unloading.

LOADING THE FURNACE

Either one or both sidewalls have been torn down during unloading. All old packing dust is removed from the furnace. Any electrode cable, clamp or busbar replacements are made before loading is started. The furnace is opened at one or both sides so that large quantities of electrodes may be run in by trucks or handled by overhead cranes. Finely ground packing dust is then sifted between the individual carbons to fill all voids, and between the outside row and the furnace walls.

After the furnace has been completely loaded, the channel irons strengthening the sidewalls are put in place and connected with the tie rods across the top of the furnace. Just as soon as a transformer is available, the side busbars are put in place. They are supported and held in position by small arms fastened to and extending from the channels. The busbars are insulated at points of contact with the channel irons.

THE BAKING PROCESS

All of the busbars of the furnace being in place, power is turned into the furnace by running the voltage regulator up to its highest point and closing the transformer circuit through the oil switch in the transformer switch room. The transformer switchboard panels are each equipped with an ammeter connected in on the primary side, a voltmeter connected to the secondary side, a power factor meter and an integrating wattmeter. Furnace log sheets are kept.

The core of the furnace, being of much lower resistance to start with, naturally takes most of the current at the beginning of the run. As a result, it heats up at a faster rate. Fig. 26 shows a comparison of the rate of heating of an average core, and the rate of heating of the temperature points. The core curve does not bear out the statement of some electric furnace men that the cores reach a temperature as high as 2,000 deg. C. during the run. The curve seems to agree with the fact that core carbons are seldom found

to be graphitized, which would be the case if the core were to reach a temperature of 2,000 deg. C.

The cores, heating up at a more rapid rate, reach final temperature sooner than the rest of the furnace, which is gradually heated by radiation from the core until it conducts of its own accord. From the fact that the resistivity of the carbons just inside the core is lower than that of any other portion of the carbon pile, the indications are that this portion of the carbon pile reaches the highest temperature.

INSULATION AND PACKING MATERIALS

Insulation of the carbon pile depends for its effectiveness upon four things: (1) The condition of the bottom of the furnace, (2) the age of the brick sidewalls, (3) the time the sidewalls have remained intact, and (4) the width of the packing material insulating layer. The bottom becomes soaked with the pitch and tar distilling off from the binder in the electrodes during baking. With an old bottom, considerable heat will be radiated off. In this case the bottom itself ceases to act as an insulator and becomes a conductor. The brick of the sidewalls are also penetrated with tar and pitch fumes, which gradually coke inside and on the surface of the brick, thereby seriously lessening their insulating power.

It may be said that up to a certain point, the thicker the packing material layer the better the insulation.

The packing material which is principally used is pulverized calcined petroleum coke, ground in a mill of the swing hammer type, to pass a 10-mesh screen. This material has almost entirely supplanted magnesia, carborundum and fireclay, which were formerly used as packing materials. Petroleum coke does not adhere to the electrodes, making them difficult to clean, as do

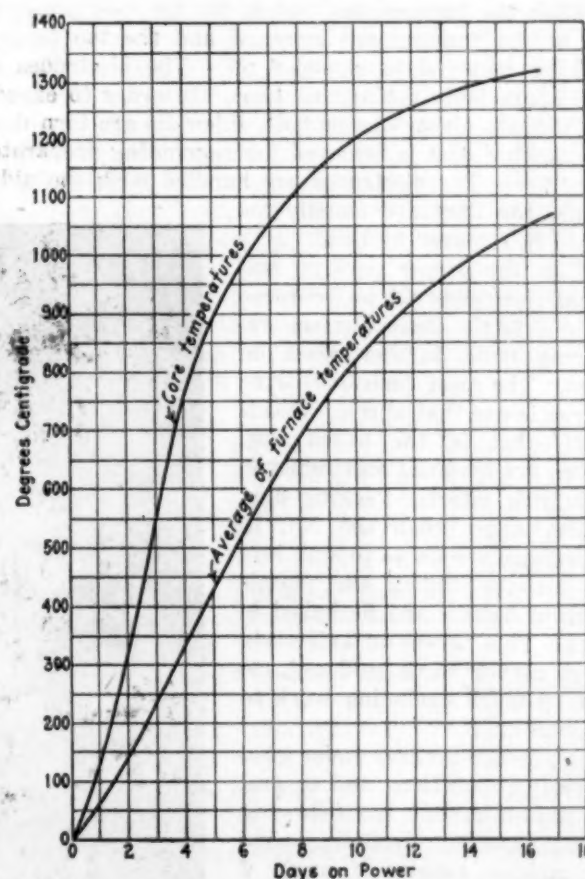


FIG. 26—COMPARISON OF CORE AND FURNACE TEMPERATURES

magnesia and carborundum. Being of the same material as the electrodes, it does not contaminate their surfaces, and furthermore is easier on the grinding mills.

During baking there is a tendency for the ash of the packing material to fuse as a result of the high temperature. Coming in contact with the sidewalls and bottoms, the packing material becomes more and more contaminated with fireclay and silica with each run. Tarry matters distilling from the electrode binder are "cracked" when they come in contact with the hot packing material on their outward passage. As a result they tend to bind together the packing material particles, and at the end of the run it is necessary to send the packing material to the grinding mills for pulverization before it can be re-used. It leaves the furnace in the form of a very friable clinker. Practically all of the packing material, save what is lost by oxidation and handling, is recovered at the end of the run.

UNLOADING THE FURNACE

As soon as the furnace has reached final temperature (1,000 to 1,100 deg. C.), the transformer circuit is opened, the side busbars of the furnace removed and placed on a furnace which is ready to go on power and the transformer circuit is closed. The furnace is then permitted to cool to a sufficiently low temperature to permit of unloading. Of course, it is understood that even if it were feasible to unload the furnace at such a high temperature, the electrodes would oxidize very rapidly and cause a large loss of material. Permitting the furnace to cool before unloading keeps the red hot carbons away from the air and prevents oxidation losses.

After the furnace has cooled, the tie rods across the top of the furnace are removed and the top layer of packing material is shoveled off. The electrodes are still appreciably hot at this time. In order to expedite the process, either one or both sidewalls are torn down. All packing dust is removed for regrinding preparatory to re-use. The electrodes are handled with the aid of tongs, for they are usually too hot to be removed by hand.

With the proper packing material, electrodes will be produced with a fairly clean surface requiring little further work on them. The most desirable baked charge is one that almost unloads itself—that is, the baked electrodes are loosened and removed with little effort. Packing dust grains larger than the No. 10 screen size are liable to sink into the carbons during the plastic stage of baking and be baked in place. This causes an extremely rough carbon to be produced, requiring much surfacing work to be done on it.

An average furnace under good operating conditions and control has approximately the following cycle: Loading (including time for making repairs if any), 2 to 4 days; on power, 12 to 20 days; cooling, 20 days; unloading

3 to 5 days; giving a minimum cycle of 37 days and a maximum of 49.

GRAPHITIZING FURNACES

Graphitizing furnaces may be considered as modifications of the standard amorphous electrode-baking furnace. Their general construction is the same, the furnaces being about the same length, but with heads somewhat narrower and not as high. In the Acheson furnace, shown in Fig. 27, busbars, rising through the floor, are connected directly to the electrode heads, the connection being broken at these points when the furnace is off power. Loading and unloading are accomplished as with the amorphous carbon baking furnace, with the exception that a central core of larger cross-sectional area is used. Power consumption is much higher, being from 3 to 5 kw.-hr. per pound of graphitized carbon. Temperature control, being relatively difficult above 1,100 deg. C., is normally dispensed with, and the run of the furnace is regulated by power input. Packing material, sidewall and top insulation are thicker, for the furnace reaches a temperature of approximately 2,000 deg. C.

The theory of the production of graphite is that carbides are formed by reaction of the amorphous carbon and the metallic and siliceous oxides present as impurities. The furnace, however, soon reaches the temperatures at which these carbides are decomposed, distilling off the metals and metalloids, leaving graphite behind as a result of the decomposition. Packing dust used in graphitizing furnaces becomes contaminated much more readily than in amorphous baking furnaces. The packing material layers serve as a cold blanket, in which the metallic and siliceous vapors condense, re-forming carbides to some extent in the layers nearer the center of the furnace and oxidizing in the cooler outer portions. It can be seen, then, that relatively impure material may be used in the manufacture of very pure graphite electrodes inasmuch as nearly all of the contamination is volatilized.

A graphite furnace cycle is approximately as follows: Loading, 1 to 2 days; on power (depending upon capac-

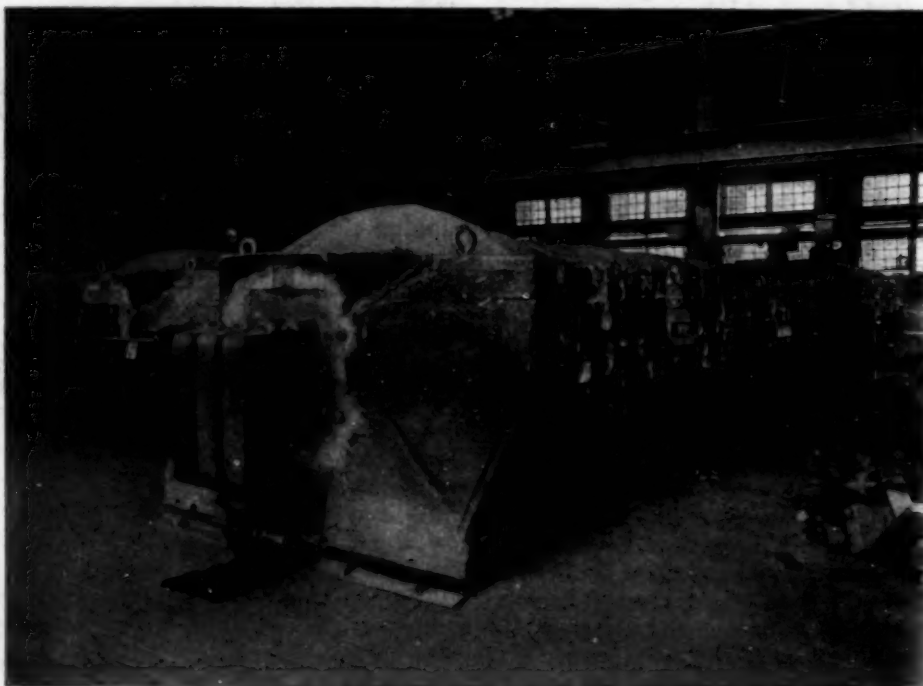


FIG. 27—ACHESON GRAPHITIZING FURNACE

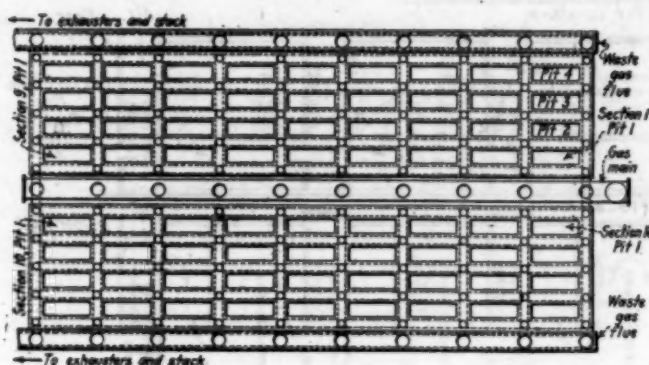


FIG. 28—PLAN OF 18-SECTION LONGITUDINAL PIT TYPE OF GAS-FIRED ELECTRODE BAKING FURNACE

ity of transformer and size of furnace), 3 to 6 days; cooling, 20 to 30 days; unloading, 1 to 2 days, giving a minimum cycle of 25 and a maximum of 40 days.

Graphitized carbons are generally cleaner than amorphous electrodes when taken from the furnace; they have fairly smooth surfaces and require relatively little further work on them. The reason is that the temperature rise is so great that the ash and vapors from the binder are distilled away from the carbons very rapidly and are condensed in the insulating packing material layers only and not in the packing dust between the carbons. The removal of the layers of insulating packing material is more difficult than in the case of the amorphous carbon furnace.

Well-graphitized electrodes have approximately one-fourth the resistivity of the corresponding amorphous carbon. Graphite carbons run from 0.00032 (Acheson, completely graphitized) to around 0.00080 ohm per inch cube (partly graphitized carbon, commonly called overbaked amorphous), depending upon the completeness of the graphitization of the amorphous carbon. The greater conversion to graphite the lower the resistivity.

Gas-Fired Baking Furnaces

Gas-fired electrode baking furnaces are all built on the "ring" principle—that is, they are in the form of an endless chain of individual units. They are regenerative, without having regenerators. They consist essentially of brick chambers, in which the green electrodes are placed, heated by gas, burning in flues along the ends and sides, and in some cases under the bottom of the chambers.

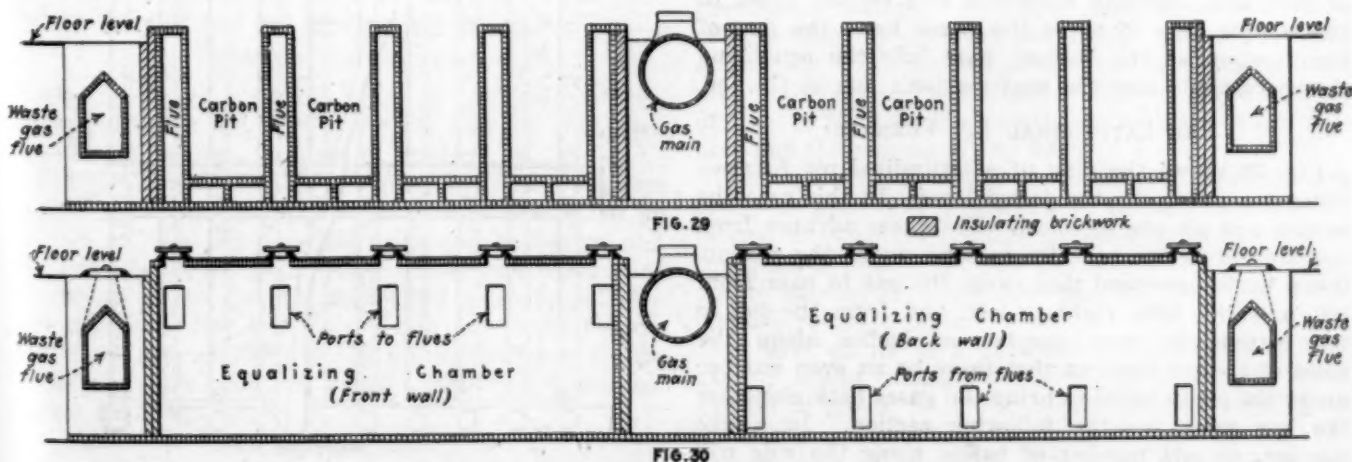
The gas-fired furnaces may be classified in four

different ways: First, in reference to the position the chambers or "pits," as they are termed, occupy in respect to each other which gives us the *longitudinal furnaces*, in which the pits are end to end, and the *latitudinal*, in which the pits are side by side. A second classification, in reference to the baffles in the flues heating the pits, gives the two classes *horizontal* and *vertical baffle furnaces*. A third, in respect to the pits, yields the *continuous* and *non-continuous pit furnaces*. The last classification is in respect to the tops of the chambers, as to whether they are covered or not. This accounts for the two classes *open-* and *closed-top furnaces*.

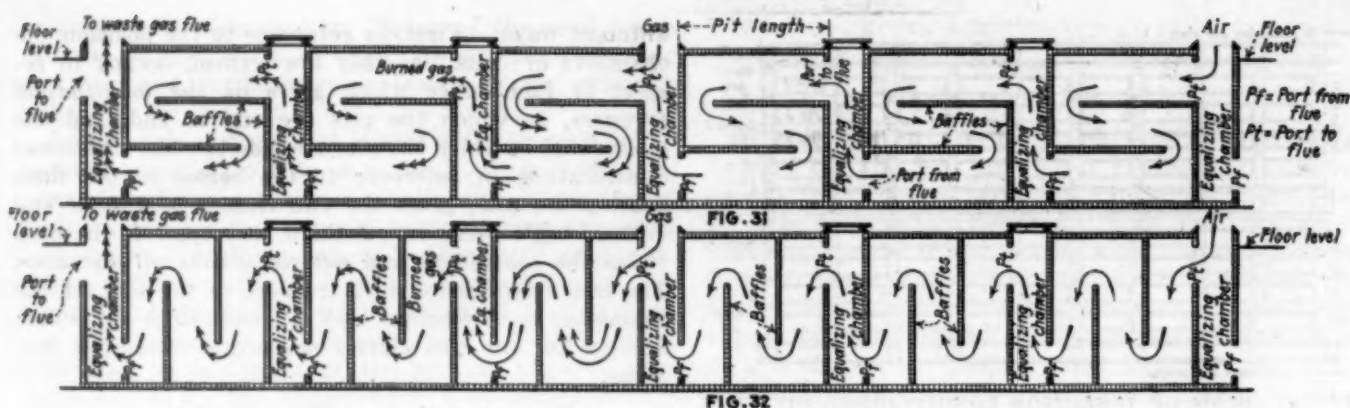
CONSTRUCTION OF A TYPICAL FURNACE

The general construction will probably be best understood in connection with the drawings of a typical furnace. Fig. 28 shows the plan of an eighteen four-pit-section, longitudinal, non-continuous pit, open-top furnace. The entire furnace forms a rectangular "ring" around the centrally located gas main. The dotted lines show the position of the flues, which are continuous for the entire furnace. The flues for the burned gases, which are usually termed waste-gas flues, are on the outside of the furnace and parallel to the gas main. Offtakes from the gas main and openings into the waste-gas flues are shown by the larger circles. Lines joining the centers of the openings in the gas and waste gas mains are parallel. Openings into the flues heating the pits are shown by the smaller circles. Connections between the gas main and flues and waste gas and flues are not permanent, but temporary and portable. When not in use, the gas-main, flues and waste-gas flue openings are closed by heavy cast-iron covers, fitting in rings or seals so that they can effectively and easily be "luted" with sand or fireclay. Fig. 29, a sectional elevation across the furnace and through the pits, affords a good conception of the relative positions of the gas-main, flues, pits and waste gas flues. The pits are separated from each other by so-called equalizing chambers with which the flues along the sides of the pits connect, as shown in Fig. 30. These chambers serve to even up pressures and volumes of gases passing through the five different channel flues.

The portion of the furnace located between two gas-main offtakes and the corresponding waste-gas flue entrances is termed a "section." Equalizing flues extend over the width of the section.



FIGS. 29 AND 30—SECTIONAL ELEVATIONS OF GAS-FIRED LONGITUDINAL PIT TYPE FURNACE
Fig. 29—Through carbon pits. Fig. 30—Through equalizing chambers, showing location of openings into chamber and ports from flues into equalizing chambers. In the rear wall the ports are below and in front above the flue level.



FIGS. 31 AND 32—SECTIONAL ELEVATIONS THROUGH MIDDLE OF FLUE SHOWING HORIZONTAL (FIG. 31) AND VERTICAL (FIG. 32) TYPES OF BAFFLES
Arrows show flow of air, gas and waste gas; P_f , port from flue; P_p , port to flue.

Gas mains are usually cylinders of steel plate lined with a highly refractive firebrick. Waste-gas flues are generally built of brick, rectangular in cross-section save for the top, which is closed over by corbelling the brick. However, no brick flue, no matter how well built, is gas tight for any considerable length of time. As a result there is a growing tendency to build waste-gas mains in a manner similar to the central gas main.

The carbon pits are formed by the brick walls of the flues, which are built of tongue-and-groove brick. The ends of the pits are tied in by the use of tongue-and-groove corner brick. All of the brickwork is laid with a refractory bond, being rubbed into place with a minimum of mortar, in order to obtain the tightest joints possible.

The reader has probably inquired of himself by this time, "Where are the gas valves?" There is a slide in the gas main at its entrance to the furnace, but this is used only when operation of the entire unit is started or stopped. There are valves of the bell or gate type in the so-called "gas elephants," which are the portable connections between the gas main and the flues.

Connection between the flue openings and the waste-gas flue is affected by the use of waste-gas elephants, built of steel plate.

In order to cause the burning gases to give up as much of their heat as possible to the section in which they are burning, baffles in the flues are used to lengthen the distance the gas must travel. Two types of baffles are employed, horizontal and vertical. Figs. 31 and 32 show sectional elevations through the middle of flues and illustrate horizontal and vertical types of baffles. In each of these the gases leave the flue of each section at the bottom, pass into the equalizing chambers, and enter the next section's flue at the top.

THE LATITUDINAL PIT FURNACE

Fig. 33 shows the plan of a latitudinal pit furnace. Flues are shown by the dotted lines. In this case the section and pit are identical. The gases advance from one section to the next by passage under the section. When baffles are used that cause the gas to pass from left to right, then right to left, and from the top to the bottom, an even number of baffles along the sides of the pit requires that there be an even number under the pit in order to bring the gases back alongside the gas main for the following section. In a like manner, an odd number of baffles along the side will call for an odd number. With vertical baffles, the gases passing up and down, and from left to right, the gases

must then pass from right to left under the pit to come back alongside of the gas main for the next section. As there is but a single flue for each section, no equalizing chambers are needed.

The Isbell-Porter Co., of Newark, N. J., has patented a gas-fired latitudinal pit furnace in which it uses clay cylinder burners spaced along the bottom of the flues between the sections. Gas and air rise through these, burning in chambers above the burners. The gases rise and pass around vertical baffles set parallel to the gas main, one on each side of each burner. As a result one-half of the gases from each burner pass around the baffles on the right hand side and one-half around the baffle on the left hand side, each meeting the gases from the burners adjacent to the one they came from. Here they burn down, pass under the pit and come up through the burners of the flue of the next section.

Present practice is to build only open-top furnaces—that is, furnaces in which the tops of the pits are exposed. In the older type furnaces, covers for the tops were used made of firebrick arches held together by channels and tie rods. The arches were portable and interchangeable for any pit or section. Often the flue system was such that the gas burned over the top of the pit under the arch in addition to burning at the sides and ends. A large number of arch or covered top furnaces have outlived their usefulness, and in-

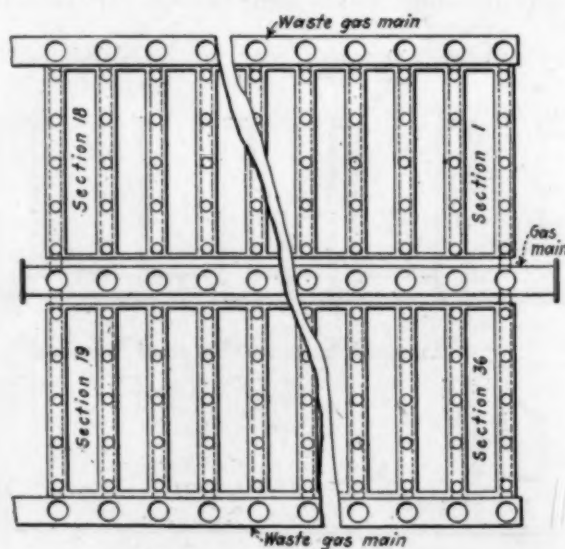


FIG. 33—PLAN OF LATITUDINAL PIT TYPE OF GAS-FIRED ELECTRODE BAKING FURNACE

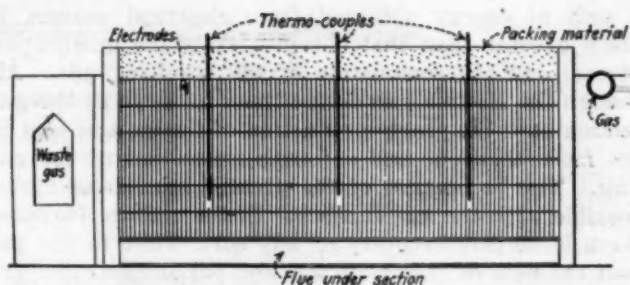


FIG. 34—ELEVATION OF SECTION OF LONGITUDINAL TYPE OF FURNACE, SHOWING LOCATION OF THERMOCOUPLES

stead of being rebuilt in the same manner, were replaced by the open-top variety.

OPERATION

The operation of all of the different types of gas furnaces is the same. It is always considered on the basis of an individual section in connection with its preceding and succeeding section. The cycle of operation for each section is: (1) Loading, (2) on waste gas (preliminary heating), (3) on fire (on gas) (heating), (4) on air (cooling) and (5) unloading. For an example, let us suppose that the furnace has been in operation for some time and we find a section ready for loading. It is loaded in a manner similar to the loading of an electric furnace. The carbons are placed on end as closely as possible, with packing dust sifted between them, thermocouples placed in desired positions and a covering of packing material placed over the top layer of carbons. Fig. 34 illustrates the loading of the latitudinal and longitudinal pit types.

It is to be understood that the five operations mentioned in the preceding paragraph are all going on at the same time, but in different portions of the furnace. The section now loaded is ready to go on waste gas. Operation is ordinarily so arranged that a little time allowance is made so that sections can be loaded a short time in advance.

Unloading is accomplished by "stripping" the pit—that is, removing the layer of packing material on top of the carbons. The layers of carbons at the top are "pulled" by means of short-handled tongs and the lower layers by long-handled ones. The pits are normally too hot for workmen to go down in them during unloading. After the carbons are removed and the pits have cooled considerably, the workmen enter and remove the packing dust from the bottom of the pit and any that has been baked in place and is adhering to the side and end walls of the pit.

FURNACE TEMPERATURES

Fig. 35 shows a typical curve of pit temperatures. From fourteen to eighteen cycles per year are completed per section, with an average of sixteen.

Flame temperatures are generally 200 or 300 degrees higher than the final pit temperatures, and often go as high as 1,400 deg. C. when using well-heated air and hot gas of higher B.t.u. value. Air temperatures at the point where the air meets the gas are between 500 deg. and 600 deg. C. Waste gas temperatures fall to as low as 350 deg. C. at the entrance to the waste-gas main, but are usually 100 or 200 degrees higher than this.

SPACINGS

In the design of baking furnaces the term "spacing" is used to refer to the number of furnace sections

through which the air must pass during preheating before it meets the incoming gas. This spacing of air and gas depends upon the rate of cooling of the sections on air, the temperature required of the air for combustion and the available suction. The air temperature desired is the highest possible, as the hotter the air the hotter the flame temperature. The greater the spacing the longer will be the distance that the air passes over previously heated sections and the closer the temperature of the air will approximate that of the section next to the one on fire. The longer the air passes through a section the cooler the section will become. Usually, however, the suction available limits the number of sections through which the air can be drawn for preheating. The cycle of operations is lengthened by increased time interval of greater spacing as any given section is on air a longer time.

The spacing of the gas and waste gas is determined by the drop of the waste-gas temperature and the available suction. It is desired to bring the waste-gas temperature to as low a point as possible with a minimum loss of the sensible heat of the waste gas.

From the foregoing description it can be readily seen that any furnace is not limited to a single-fire, but may have many more. In this case we must make allowance for another spacing, that of fire to fire. It

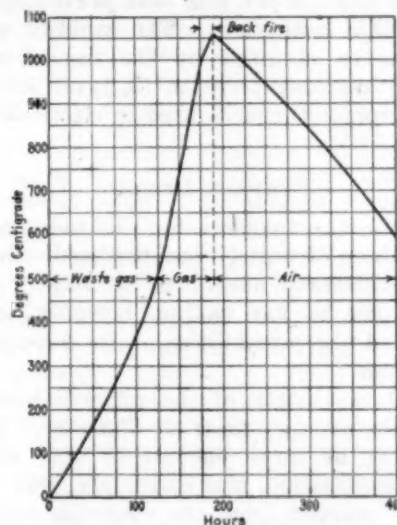


FIG. 35—BAKING CURVE OF PIT TEMPERATURES IN TYPICAL GAS-FIRED FURNACE

must be great enough to allow time for the preparatory operations, loading, unloading and repairs to take place before the cycle of one firing follows the cycle of another. The number of sections to a furnace and pits to a section is theoretically unlimited. The number of fires is fixed by the number of sections to the furnace and the spacing of the fires.

The fuel used for firing the furnace is generally raw producer gas. The producers in present practice are located as near the furnace as possible so that all of the sensible heat of the raw gas may be utilized. Producers operate on bituminous gas coal, and are of the updraft pressure type.

At first glance at a gas-fired electrode baking furnace it seems strange that only an extremely small amount of gases, from the distillation and cracking of the green carbon binder, is given off through the uncovered tops of the pits. The walls of the pits are not gas-tight and as the flues are under suction, the pits come under suction through the crevices of the walls.

As a result the vapors and tarry matters arising from the distillation-cracking action of the binder are drawn off into the flues and become a portion of the waste gas. For this reason waste gas is usually of a heavy greenish-yellow color, having a marked deleterious effect on vegetation. In the earlier stages of the industry, when electrode plants were located at places sparsely populated, this condition was not important. With increases in population, the necessity of eliminating the nuisance of the waste gas became apparent. Electrode works started to scrub waste gas and to recover, as a product of the scrubbers, a thin liquid tar.

CONTROL

Control on the furnaces is obtained by regulation of the cross-section of the air openings, by regulation of the gas-elephant valves, and waste-gas valves or "dampers." Additional control on individual sections is obtained by regulation of the ports from and to the flues in the equalizing chambers.

A more or less unsuccessful attempt has been made to replace the electric thermocouple pyrometer in this industry by the optical pyrometer. However, the relative unreliability of the optical instrument at lower temperatures, the difficulty of training unskilled workmen in its use and the trouble in procuring black body conditions in pipes in the pits have prevented a general adoption of this instrument. The rapidity with which readings can be obtained by the use of an optical pyrometer is a strong point in its favor in the operation of the type of furnaces used in electrode manufacture.

FURNACE DESIGN

As gas-fired ring furnaces for electrode baking have not as yet been definitely standardized, their design involves a considerable amount of cut-and-try procedure. The entire field of gas baking, however, is a promising one, and the possibilities of its development are relatively great.

In general the length of the pit will have to be a multiple of the average electrode diameter. The waste-gas flue must be large enough to take care of all products of combustion, plus excess air, plus the vapors distilled and cracked from the electrode binders. Allowance must be made in designing the waste-gas flues to take care of the products of the maximum number of fires possible on each side of the furnace. The latest furnaces built have been of the longitudinal pit, vertical baffle, open-top variety. Vertical baffles, with openings through the top of the flues, permit the possibility of cleaning the flues by blowing them out with compressed air or sucking out dust, pieces of brick or mortar, etc. Horizontal baffles do not permit this.

In the design of the flues (and equalizing chambers if any) such combinations must be used as will give as intimate a mixture of the air and gas particles as possible, for the better this mixture the better will the gas be burned and the greater the heating power obtained from the gas. Having the gas and air come from opposite directions, meeting, and continuing at right angles to their previous flow, provides a good and intimate mixture.

A comparison of gas and electric baking shows that both types have low thermal efficiencies.²⁰ The cost of

a unit of energy obtained from electrical sources is much greater than that obtained from the gasification of coal and the combustion of the resulting gas. Although the electric unit is ten times as large as the gas section unit, the yearly production of the electric unit is not more than one and a fourth times that of the gas unit. This is because of the greater number of cycles possible with the gas furnace. In the electric furnaces there is no heat recovery of any sort, while in the gas unit the heat of the waste gas and baked electrodes are both partly recovered.

COMPARATIVE ADVANTAGES OF GAS AND ELECTRIC BAKING

Gas baking is gradually but surely replacing electric baking because of its cheaper cost. All of the recent installations of electrode baking furnaces, except for graphitization, where gas baking is not a competitor, have been of the gas-fired variety. The greater ease and closeness of control of the gas-type furnace is a decided advantage over the electric. The gas type permits the more or less valuable products of electrode baking to be recovered. In the electric type all sensible heat of the finished baked electrodes is entirely lost, while in the gas type it is almost entirely recovered and used to give preliminary heating to the other materials. The maximum temperatures are much greater in the case of the electric type than in the case of the gas type, and the latter is limited by the softening point of the furnace brickwork and the possible air temperatures obtainable. Both types use about the same amount of absolute energy in baking and a large part of the difference in cost may be shown to be due to the fact that a heat unit from gasified coal is much cheaper than one from electric power. The average life of an electric furnace is about three or four times that of a gas furnace.

Finished electrodes from electric furnaces are more difficult to clean than from gas-fired ovens, but the electric baked have the advantage of having a somewhat lower resistivity. Packing dust after being used in electric furnaces is more difficult to grind and prepare for re-use than is the case with the dust from gas-fired units where fusing temperatures for the ash of the packing material has not been reached. Electric furnaces are generally very dirty, as the products of baking burn on the outside of the furnace. Gas-fired units, on the other hand, have the baking products drawn off in the stack along with the waste gases and as a result properly operated gas units are comparatively clean.

EDITOR'S NOTE: *The concluding article of this series, which will discuss the cleaning, machining, testing and shipping of carbon electrodes, will be published in a subsequent issue.*

Anti-Corrosion Association

An "Association of Manufacturers of Non-Corrodible and Anti-Corrosive Products" (a name reminiscent of Dr. Herty's organization) is being organized in England by firms making stainless steel, acid-resisting chemical plant, anti-corrosive paints, boiler preservatives and the like. It is proposed that the association should act as an Institution of Anti-Corrosion Engineers and also as a Chamber of Commerce for firms making any material or appliance connected with the prevention of corrosion. It is further suggested that a public exhibition of non-corrodible and anti-corrosive products should be held in the near future.

²⁰The heat necessary to raise the material to the required temperature (calculated from the specific heat of the material) divided by the actual heat used; See Richards, "Metallurgical Calculations."

Book Reviews

ELEKTROCHEMIE WASSERIGER LOSUNGEN (Electrochemistry of Aqueous Solutions). By *Dr. Fritz Foerster*, professor of the Institute of Technology of Dresden. Third edition, revised and enlarged. 900 pp. with 185 illustrations. Leipzig, 1922: Johann Ambrosius Barth. Series of Applied Physical Chemistry Manuals edited by Prof. Dr. G. Bredig.

The first edition of this work appeared in 1905, and the second in 1915 during the early part of the World War. The advances in electrochemistry, both theory and practice, stimulated by the demands of war were of such consequence as to make a third edition, enlarged and improved, highly desirable. In this third edition Dr. Foerster has covered a very broad field in an exceedingly comprehensive manner. The arrangement of the text follows the second edition closely, with the more recent additions to the book coming under their proper chapter headings.

An idea of the broad scope of the field of electrochemistry covered may be had from the following chapter titles, as they appear in the text: 1. Electrical energy and direct current electricity in general. 2. Faraday's law and its practical deductions. 3. Theoretical deductions from Faraday's law. The electrolytic dissociation theory. 4. Migration of ions. 5. Both voltage and energy efficiency. 6. Resistance of electrolytes. 7. Electro-osmosis. 8. Production of electrical energy in galvanic elements. 9. General theories of electrolysis. 10. Electrolytic evolution of oxygen and hydrogen. 11. Special electrochemistry of metals. 12. Applications of electrochemistry to the metals. 13. Electrolytic reduction. 14. Special electrochemistry of the halogens. 15. Electrolytic oxidation.

Dr. Foerster endeavors to show the value of theoretical electrochemistry as applied to practice, and in this he is especially successful in the chapters on Faraday's law and its practical deductions, applications of electrochemistry to the metals, and special electrochemistry of the halogens.

Those interested in the electrochemistry of aqueous solutions will find this book a very up-to-date, comprehensive reference.

"AGGREGATION AND FLOW OF SOLIDS." Being the Records of an Experimental Study of the Microstructure and Physical Properties of Solids in Various States of Aggregation. By *Sir George Beilby*. London and New York, 1921: MacMillan & Co. 256 pp., 106 figures. Price \$6.50.

Dr. Beilby's work is well known to chemists, physicists and metallographists. He put forth the amorphous theory of metals pertaining to the films on polished surfaces and amorphous

metal generated at slip planes by plastic deformation. The present book deals not only with metals but with all solids, and is in eleven sections.

The section on the microscope is interesting, because in it is illustrated how the microscope can be utilized to determine the type of surface on a solid. Dr. Beilby devised a method of observing very small particles some years before the ultra microscope was described.

In the section on surface tension a number of experiments are described on the character of oil films and of thin metal leaves. When a water surface is touched with a needle which has been dipped in an oily liquid there occurs a definite sequence of changes in the state of aggregation. A continuous film first forms over the surface in all directions. Two forces are present, one which tends to keep the oil in the form of a continuous film and the other which tends to reduce the surface area of the oil and hence to change it into spheres. The spreading continues until the film becomes so thin that the surface tension force of the oil dominates the attractive force between water and oil. The surface then becomes punctured all over with small round holes, which increase in size. At the beginning of the change the oil network is continuous, but the process of gradual change produces a form in which the water surface becomes continuous and the oil concentrated in isolated drops. The state of equilibrium of each drop depends on the surface tension of the oil and the attractive forces between water and oil at the contact. Similar changes take place in thin metal leaves; for instance, if a leaf of continuous gold is mounted on glass and heated to 400 deg., the continuity of the gold completely disappears, and the isolated portions of gold become thicker than the original leaf, due to the forces of surface tension. "The foregoing illustrations show that an increase in the mobility of the molecules of a solid, which is still far short of the freedom of the liquid state, is sufficient to enable the force of surface tension to assemble the molecules of a thin film into new forms of aggregation."

In Section III the author gives the outstanding characteristic of a solid as "rigidity," which implies the retention by the molecules of fixed positions relative to each other so that energy has to be expended to change these fixed relations. A number of types of aggregation are considered. Atoms or an aggregation of atoms forming molecules may be arranged in definite and repeating patterns to form crystals. Such crystals may be perfectly dense or, under certain conditions, may exist in an open formation.

Particularly interesting is the formation of calcium carbonate. Carbon dioxide from the air first forms a thin film of calcium carbonate on a drop of lime water. With the continued addition of CO₂, the film breaks up into particles (which the author calls "spicules") of such small size as to move about with Brownian movement.

"If two spicules have an encounter, they at once coalesce and the enlarged unit proceeds to fresh encounters till its mass becomes so large that it sinks to the bottom as a granule and rests there. Its power of absorbing other spicules having increased with its mass, it now acts as a center of attraction to the still active spicules which play around it with swift to and fro movements, ultimately darting into it and being absorbed. By focusing on the bottom of the cell the granules were seen to grow till they took the outward form of rhombs."

Open formation in metals may be caused by exposing them red hot to ammonia. The general effect is a slight increase in weight with a continuous change in structure—holes are developed, increasing the volume enormously. "Rolls of fine wire gauze of copper were heated in a porcelain tube at 800 deg., and a current of ammonia was passed through for 70 minutes. It became so brittle it could not be bent without breaking. Its color was bright pink, and its surface was so completely disintegrated that metallic luster had disappeared. Under the microscope the bubble structure was very obvious. The diameter of the wires had increased two or three times."

Perhaps the author is best known for his work on polish and surface condition of solids. In Section V two fundamental principles of polish are put forth: 1. In every substance sufficiently homogeneous to be polished at all, the fundamental principles on which polishing depends are absolutely identical. 2. The polished surface on a solid substance is as truly due to the presence of a surface tension skin as is the surface of a liquid.

Evidence is given to substantiate these principles. The author holds that amorphous substances like glass have liquid surface tension skins on their cold surfaces, different from the structure at a fracture. The latter surface can be polished cold so as to produce a surface tension skin; in fact, the resistance to polish on a broken surface of glass is much less than on one already polished or one cooled from a high temperature. When a surface of a crystal is polished a surface tension skin many molecules thick is formed. This skin is vitreous-amorphous in character. The surface of calcite crystals can be scratched and these can be completely covered by polish, yet caused to reappear by proper etching.

A sharp distinction is made between grinding and polishing. It was formerly believed that polishing was only very fine grinding and that grinding was the cutting away of a substance by the hard particles of the abrasive. The author shares the old view as regards grinding, but puts forth the hypothesis that polish is the result of surface flow caused by the gripping of the surface molecules by the particles of the polishing powder.

Some interesting experiments are described on the formation of similarly oriented crystals of sodium nitrate.

These crystals permitted to form either on a cleavage plane or polished surface (parallel to a cleavage plane) were oriented similarly, showing that the crystalline attraction of the calcite extended through the supposedly vitreous-amorphous polish film. Realizing that this experiment might cast doubt on the existence of a vitreous film, the author deposited isotropic films of calcium carbonate and oxalate on a polished surface of calcite and then permitted the sodium nitrate crystals to form. Up to a certain thickness of deposited film (many molecules thick) the sodium nitrate showed the parallel growth, but beyond that a perfectly random arrangement.

Sections VI and VII deal with the generation of amorphous metal at the slip planes by plastic deformation of ductile metals. The mechanical properties of metals are considered from the viewpoint of the amorphous theory. The treatment is substantially the same as in the author's May lecture (1911) before the Institute of Metals, and discussed at length by the reviewer in *Chemical & Metallurgical Engineering* for Oct. 12, 1921 (vol. 25, p. 697). It is postulated that plastic deformation produces vitreous-amorphous metal at the slip planes; the amorphous metal is hard and hence the hardening by cold work. The amorphous metal is mechanically stable because of the relatively low temperature. When a cold-worked metal is heated the amorphous metal recrystallizes, restoring softness.

It is the author's opinion that flow by slip takes place in rocks and in ice under conditions of great and unequal pressure, rather than softening by the lowering of the melting point. An ice column nearly 60,000 ft. thick would produce only enough pressure to effect melting at a temperature of -12°C . Therefore, plastic flow and recrystallization seem necessary to account for the flow in glaciers.

In Section IX a tentative hypothesis of molecular "pulsation cells" is offered. "The molecule, which for simplicity we shall take to be monatomic and spherical, is elastic and is capable of responding to ether-borne vibrations by vibrations of a period proper to itself and of an amplitude proper to the temperature attained. Its elasticity may be either of form or of volume; again for simplicity's sake, let us assume the elasticity to be that of volume. The vibration of the spherical molecule will be spherical pulses. The effect of these pulses, the period of which is necessarily rapid, will be to surround the sphere with a 'pulsation cell' the thickness of which will depend on the amplitude of the pulsations. The amplitude of the pulsations will in its turn depend on the temperature, so that for each temperature the cell will be of definite thickness.

"When an aggregate of spheres at the absolute zero is energized by heat, each molecule as it becomes energized will surround itself with a pulsation cell proper to the temperature which it has reached, and the molecules will be

pushed apart to a corresponding distance."

In 1857 Faraday gave the Bakerian lecture entitled "The Experimental Relations of Gold and Other Metals to Light." Phenomena of the color of light transmitted through thin gold leaves were described but not explained. In Section X Beilby offers an explanation of these phenomena which he believes agrees with all of the experimental observations. The key to the interpretation is the decrease in density of thin films of metal on mild heating. The particles arrange themselves in "open formation" as the first step in the change in state of aggregation under the influence of surface tension forces. The open formation accounts for the observed decrease in density, enormously reduced electrical conductivity, the optical phenomena and sponginess as shown by the absorption of water and other liquids.

The book contains 106 illustrations, many of which are highly magnified micrographs, a collection which is unique in individuality and variety. A number of excellent colored illustrations are reproduced.

Although the experiments were made during the last 20 years, the author states in the preface that the conclusions are based on mature consideration just prior to publication. Besides containing accounts of many interesting and varied experiments the book is a fine piece of scientific literature.

The greatest value of the book, in the opinion of the reviewer, lies in the experimental methods described. The author combines almost infinite pains in performing with rare ability in planning his experiments; their boldness and originality are equaled only by their simplicity. The author's appreciation of important variables and his skill in controlling them entitles him to a place among the foremost experimenters. It is a pleasure to acknowledge the great indebtedness of metallographic science to the work of Dr. George T. Beilby.

ZAY JEFFRIES.

METALLOGRAPHIE. By W. Guertler.

Vol. II, Part I, Section 3: Elektrochemische Metallkunde, by Dr. R. Kremann. Berlin, 1921: Borntraeger.

Dr. Guertler writes in his preface to this volume that the enormous expansion of scientific knowledge in the field of metals and alloys, in addition to certain unfavorable circumstances growing out of the war, have made it impossible to carry out his original plan of completing the handbook under his own authorship. The present volume is accordingly the work of a collaborator, Dr. Kremann. One finds no difficulty in understanding this change of purpose when it is recalled that several thousand pages of the handbook have already appeared. This undertaking is evidently planned with the intention of assembling under one title in a series of volumes everything pertaining to theory and practice within the metal industries no matter how expansive the

effort becomes or how long it may require for completion. Those of us who work in this field should therefore receive these contributions with extreme satisfaction, feeling grateful that so much is being done to chart the progress in a field of growing complexity.

The volume in hand constitutes the third section of the first part of the second volume of the handbook and comprises about 650 pages under the sub-title, "Electrochemical Science of Metals." It is essentially a critical review of published investigations describing the change of potential with concentration in binary alloy systems. Five ternary systems are also included. The literature is treated from the constitutional standpoint and the relations between electrochemical potential and various established types of constitution are set forth in detail. Those who desire to consult the work of individual authors quoted in this volume will run into difficulty, inasmuch as, in harmony with the practice in earlier volumes, no direct references are given. The reader must be content with the bare knowledge and date of authorship until, at the end of the entire undertaking, a table listing the literature appears.

About thirty pages of the book are occupied by introductory statements of theory and methods of potential measurements, including a six-page discussion of passivity.

Following the treatment of binary alloy systems, some attention is paid to the subject of alloying by electrochemical methods. The author's discussion of the use of potential-concentration curves of binary alloy systems as a means of determining the alloy compositions resulting from ordinary electrolytic precipitation reactions should be of especial interest to those generally engaged in alloy investigations. Qualitative or semi-qualitative data defining the character of precipitate produced in many reactions of this sort are included. Thus we read on page 444 that the lead precipitated by cadmium from dilute solutions of lead salts is practically pure and on page 451 that tellurium precipitates a compound of the formula Ag_2Te from silver nitrate solutions. As very little of the data on this general subject is of recent origin, it should be used with caution.

The subject of electrolysis, mainly from the standpoint of alloy formation at the cathode, is handled elaborately, with reference to a large amount of well chosen data. Important combinations of metals such as Cu:Zn , Cu:Sn , Cu:Ni:Zn and amalgams are discussed.

Other important topics included are the electrolysis of molten salts, anodic behavior of metals and alloys and finally a brief chapter on electrolytic refining of metals.

This volume probably makes use of the largest collection of references relating to the electrochemical properties of metals thus far assembled. It is unfortunate that these references are abbreviated so as to be virtually useless in their present form.

C. H. MATHEWSON.

Synopsis of Recent Chemical & Metallurgical Literature

Internal Stress in Brass Tubes

A method of studying the effect of low-temperature reheating on the relief of internal stress in metal is used by Moore and Beckinsale¹. If a flat strip of metal t inches thick is bent to a radius r , the stress in the outer fiber (if below the elastic limit) is equal to $Et \div 2r$, where E is Young's modulus. Now while held in this shape, a heat-treatment is given it, after which the strip is released. It will assume a form somewhere between the straight line and an arc radius r , and from the resulting curvature the stress relieved during heat-treatment can be computed.

Internal stresses rapidly fall during the first few minutes of low-temperature anneals, the faster the higher the temperature. Thereafter, further relief becomes slower, almost vanishingly small. However, internal stresses in hard drawn condenser tubes as high as 33,500 lb. per sq.in. are reduced to 12,000 lb. after 60 minutes at 250 deg. C., a heat-treatment which also improves their physical properties without softening the metal, as shown by the following results:

	Original Tube	Annealed 60 Min. at 250 Deg. C.
Brinell hardness.....	164	163
Proportional limit	27,000	45,000
Yield point (extension 0.2 per cent)	71,200	77,600
Ultimate strength	85,000	83,300
Elongation	11	17
Reduction in area.....	28	51

It has already been found that season-cracking probably requires internal stresses of 20,000 lb. per sq.in.; certainly it is very improbable if they are reduced to 10,000 or 11,000 lb. per sq.in. even when submitted to ammonia fumes. Pushing the heat-treatment to 300 deg. C. even for 10 minutes will reduce ordinary internal stress to below the lower figures, and cause almost equal improvement in the physical properties noted in the above table. Most severely stressed tubes would require 60 minutes at 300 deg. C.

Bengough and Hudson² recommend a 30-minute oxidizing heat at 280 deg. C. for aid in resisting corrosion. It is now seen that such a heat would likewise be a sure preventive against season-cracking and splitting from internal stresses.

Utilization of Iron Ores Containing Vanadium

Iron ores containing low percentages of vanadium have not yet been used for the production of V with the exception of some converter slags, emanating from certain Minette ores. Attention has been given to bituminous substances containing vanadium, even

though sparingly, because these materials give a high-grade product simply through burning.

Swedish magnetic iron ores containing appreciable amounts of V also generally contain titanium in considerable quantities as ilmenite, according to Björn P. F. Kjellberg, state inspector of mines, Sweden, (*Jornkontorets Annaler*, 1921, p. 147). Magnetite appears to hold the vanadium, but the minerals as a rule occur in such a manner that even after the ore has been finely ground they cannot be completely separated, and it is generally impossible to produce a concentrate containing more than 50 to 55 per cent of iron, up to 1.5 per cent V, and 5 to 15 per cent Ti. A remarkable advantage of these Swedish ores is that they generally are very low in phosphorus.

Rich concentrates having the lowest possible percentage of Ti may be smelted with charcoal in an electric pig-iron furnace, slagging both the V and Ti. The slag consequently contains a considerably higher percentage of these metals than the raw material. It is then given a roast with salt and iron sulphide, and leached with hot water. Vanadium in solution is precipitated as iron vanadate by ferrous sulphate, filtered and washed. After drying it contains 50 to 55 per cent vanadic oxide (V_2O_5).

Another possible method of refining the slag is to smelt it with niter cake and coal, and leach out the sodium-vanadium sulphide with hot water. Excess acid precipitates the V as sulphide, which after calcination becomes V_2O_5 .

Low-vanadium, high-titanium concentrates can be turned into color material (red ochre) and vanadium extracted at the same time. The fine-ground dry material is stirred into sulphuric acid and the pulp heated gently under intermittent stirring until the metals are converted into sulphate. This is heated to a comparatively low temperature to drive off the sulphuric acid, which transforms the Fe and Ti into insoluble oxides, a pigment of fine color and superior qualities. Soluble V compounds are extracted by a hot solution of caustic soda, precipitated as vanadium sulphide and calcined.

Recent Chemical & Metallurgical Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Zirconia Refractory—By adding a limited quantity of steatite to zirconia and then heating the mixture, a new compound is formed that makes an excellent refractory material for many purposes if the steatite is not less than 15 per cent nor greater than 40 per cent. When the steatite is much less than 15 per cent, the compound lacks strength and uniformity, while if in excess of 40 per cent its fusing point will be too low. The best results are

produced when the compound is formed from 80 per cent zirconia and 20 per cent steatite, the resulting material having great physical strength over a wide range of temperatures and having a fusing point but little lower than zirconia, thereby filling all the requirements of a high refractory material.

In making the refractory material, the zirconia and steatite are separately finely ground and then thoroughly mixed in definite proportions by weight. Water is then added in sufficient quantity to enable the mixture to be pressed into bricks, which are thoroughly air dried. After drying, the bricks are fired in an electric or other suitable furnace until they are fused. The fused compound is then cooled, preferably in water, and thereafter ground to such a degree of fineness that the particles will pass through a 30-mesh or finer screen. The object in fusing the mixture is to produce a uniform compound that will not shrink after being molded into final form, the zirconia and soapstone shrinking to a considerable extent when first heated.

The finely ground compound is then mixed with a small percentage of volatile binder, preferably 1½ per cent of gum arabic and a very small quantity of water, and pressed under high pressure into final shape as bricks, crucibles, insulators and the like. They are then fired at a temperature that will completely volatilize and drive off the binder and soften but not fuse the compound. The resulting articles after cooling are hard, dense and smooth and of their original shape and size, there having been no warping or shrinking during the firing.

Among the many advantages of the new refractory material are its high melting point, its great strength at all temperatures up to its softening point, its ability to withstand the cutting action of molten metal, the capability of making a refractory material of varying strength and heat resistance by varying the proportions of the ingredients to meet any requirements. (1,418,372; Charles A. French, assignor to International Harvester Co. June 6, 1922.)

Mold for Hot-Top Ingots—S. E. Hitt of Elyria, Ohio, and J. I. Peyton of Chicago, Ill., propose an ingot mold whose topmost part is hollow cast. A vacuum is maintained in this space and it is claimed that by this means the top part of the solidifying ingot will remain liquid much longer than the lower, thus acting as a sink-head to fill any pipe or contraction cavity which may be formed. A hollow-cast top may also be bolted to the top of an ordinary mold. Various precautions are mentioned concerning the manufacture of the mold, its design and the maintenance of the proper vacuum. (1,422,572; July 11, 1922.)

SO₂ From Smelter Smoke—G. C. Howard of Tacoma, Wash., patents certain improvements in the process of recovering SO₂ from dilute mixtures, such as smelter smoke. He delivers cooled smoke to the bottom of an open

¹Further Studies in Season-Cracking and Its Prevention," British Institute of Metals, March, 1922, meeting.

²Fourth Report to the Corrosion Committee," *J. Inst. Metals*, 1919, I, p. 207.

"enriching" tower, passing upward through sprays of SO_2 solution. From this tower the smoke then goes through a packed absorption tower. A water current in closed circuit is circulated in a contrary direction through both these towers, sufficient being drawn off to supply the gas plant. Here part of the solution passes through a heat interchanger and thence to a boiler, where the SO_2 is driven off. This gas passes to a cooling tower, where it is cooled by the remainder of the solution from the absorption plant. Thence the cool gas is dried in a scrubber through which H_2SO_4 is circulated, when it is ready for liquefaction. Warmed solution from the cooling tower just mentioned passes to the boiler either direct or through the heat interchanger at the entrance of the gas plant. Spent liquor emerging cool from the heat interchanger is returned to the enriching tower. Thus the operation requires a minimum of make-up water and a minimum amount of heat. (1,417,066 and 67; assigned to American Smelting & Refining Co.; May 23, 1922.)

Electric Smelting Furnaces for Zinc—Filip Tharaldsen, of Trondhjem, Norway, patents such a furnace which is essentially a smelting chamber inclosing an arc. Charging is effected through a tall shaft, whereby much volatile matter is driven from the raw materials before it enters the smelting chamber. Zinc vapor is conducted to a series of inclined condensers, each one air-jacketed to absorb the heat from liquefaction and to regenerate the temperature. Slags are drawn from the furnace periodically, and further treated, if their zinc content warrants. (1,417,953; May 30, 1922.)

Manufacture of Butyric Aldehyde—According to British patent 166,249, which has recently been taken out in this country, butyric aldehyde is prepared by passing normal primary butyl alcohol in a vapor state over a fused cupric oxide catalyst. The temperature of the catalyst and vapor is maintained at between 200 and 350 deg. C., although the preferable temperature range is between 280 and 320 deg. The vapors pass through a condenser, and are there separated from hydrogen. The resultant butyric aldehyde may be separated from the unchanged butyl alcohol by distillation, and the latter returned to the catalyzers.

A particularly high percentage conversion is claimed for this process. Thus, in a 2-in. copper tube packed for 26 in. of its length with fused cupric oxide it is possible, while working at 300 deg. C., to pass through 240 c.c. per hour of normal butyl alcohol, and obtain 75 per cent conversion in one passage. (1,418,448; David A. Legg, assignor to Matthews Atkinson Adam; June 6, 1922.)

Separation of Petroleum-Oil Sludges—Sterling H. Diggs, assignor to the Standard Oil Co. of Indiana, has been granted a patent for the treatment of the acid sludge such as is normally obtained in the manufacture of lubricants

from petroleum oil. The method consists of treating this sludge with an intimate mixture of water and the sludge sulphonic acids of the character usually derived from the fuming-acid treatment of mineral oil. The fuming-acid sludge referred to is produced by the action of relatively large quantities of fuming sulphuric acid from heavy petroleum oil of the character used for medicinal purposes. Prior to the mixing, the fuming-acid sludge has usually had the bulk of its sulphuric acid separated from it. This may be readily accomplished by the addition of water to the sludge, followed by the thorough boiling of the mixture and settling.

The mixture of oil sludge, fuming-acid sludge, gas oil and water or weak acid having been made, this is now steamed until it is nearly at boiling temperature. The sulphuric acid contained in the sludge separates out at the bottom of the tank in a form of about 30 deg. Bé. acid. This is drawn off, more water or weak acid added, and the mixture again steamed, after which a second stratification takes place. The process may be repeated until the gravity of the acid recovered is from 8 to 10 deg. Bé., beyond which stage it is unnecessary or unprofitable to carry the concentration. (1,418,781; June 6, 1922.)

Preparing Size for Paper Making—The resin size ordinarily used in the manufacture of paper is a mixture of resin soap with varying amounts of free resin. In dissolving such a mixture, the resin soap acts as an emulsifying agent for the free resin, and it is evident that the facility with which emulsification will take place must decrease with an increase in the proportion of free resin. The ordinary size used by paper makers contains about 25 per cent of free resin, but it is often desirable to use proportions of free resin amounting to about 45 per cent of the total resin.

Dr. Oliver Kamm, assignor to the American Writing Paper Co., of Holyoke, Mass., has patented a method which consists in heating the size with an exactly sufficient quantity of water to form a clear emulsion of size-in-water at a given temperature and in diluting this emulsion by pouring it into a large volume of water. The preferred temperature for the preparation of the first concentrated emulsion is the boiling point of the solution. Cold water may be used for the subsequent dilution.

In preparing dilute resin emulsion containing 30 per cent of free resin, one part of F grade resin is treated with one part of water containing sufficient quantity of sodium hydroxide in water to convert 70 per cent of the resin into resin soap. This mixture is heated until a clear homogeneous solution is obtained. Four to five parts of hot water are then added and the mixture heated practically to the boiling temperature until a clear homogeneous solution is again obtained. The actual

quantity of water to be added is dependent to some extent upon the particular grade of resin used. This clear emulsion is then diluted by pouring it into 45 parts of water, thus producing a diluted solution containing approximately 2 per cent of total resin. (1,415,363; May 9, 1922.)

Paint Pigment—LeRoy Baker of St. Louis, Mo., has received a patent for the production of a sunproof zinc white pigment, the particles of which are claimed to be of uniform size and of microcrystalline formation. A solution of zinc sulphate is heated with steam and subjected to air under pressure. At the same time a solution of a metallic peroxide, such as calcium or barium peroxide, is added in the proportion of about 1 per cent by weight of the zinc present. The hydrated zinc oxide thus formed is filter-pressed and mixed with a solution of barium sulphide. The precipitated pigment is dried and calcined. It is then reground while wet, again washed, filter-pressed and finally dried and packed for the market. The inventor claims that the properties of this pigment are the result of the precipitation from basic solutions. Reference is also made to application filed July 16, 1919, Serial No. 311,296. (1,413,565; April 25, 1922.)

Recovery of Volatile Solvents—A number of interesting improvements have been outlined by G. W. Coggeshall and T. M. Rector in their recently patented process for the recovery of volatile solvents such as alcohol and the like from material in or with which they have been used in the coating of fabrics. The general process with which these investigators worked consisted in passing a current of gas such as air over the coating material, the gas being warmed to a temperature sufficient to volatilize the solvent. The mixture of gas and solvent vapor is then brought into contact with a suitable adsorbent such as charcoal or activated carbon. The volatile vapors are adsorbed by the material and the mass is then heated to volatilize the solvent which may be recovered by condensation. A method is outlined for reducing the volume of fresh air needed, thereby increasing the concentration of solvent vapor in the air-vapor mixture passing to the adsorbers. It has also been shown that if a slow current of air or of a gas of greater molecular weight is passed through the adsorbent during the heating of the adsorbent mass to drive off the vaporizable solvent and this incondensable gas is passed along with the condensable vapor through the condenser, a larger percentage of vaporized solvent is removed from the mass of the adsorbent in the same length of time than when no incondensable gas is so used. It has been found to be advantageous to remove such gas from the condenser or collecting vessel, reheat it and again pass it through the heated adsorbent material. (1,418,363; assigned to the Institute of Industrial Research, Inc., of Washington, D. C., June 6, 1922.)

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Potash Bounty Defeated in Senate

Party Lines Swept Aside in Vote of 32 to 30 Against Subsidy Proposal—
Small Chance Now of Saving Potash
From Free List

THE PROPOSAL of the Senate Finance Committee to substitute a bounty for the protective duties previously prescribed for potash was rejected by the Senate on Aug. 8 by a vote of 30 to 32. The vote was taken in committee of the whole. The first step was to reject the original proposal of the Finance Committee providing various rates of duty upon the importation of potash. This was done by a vote of 66 to 1, the single objection being registered by Senator Shortridge, who apparently was willing to let well enough alone. The next action, therefore, was to subject potash to the bounty provision, and that failing it was left upon the free list. An opportunity will be afforded to bring the matter up again when the bill is considered in the Senate proper, but it is thought that the chance is slight of saving potash from the free list.

WOULD FOSTER INDUSTRY

During the discussion of the item it was admitted frankly that the bounty was substituted for the duty when it became apparent that the duties proposed would be voted down. Senator McCumber, chairman of the Finance Committee, in urging the adoption of the bounty proposition pointed out the importance of having a domestic potash industry to curb the monopolistic control of the other sources of supply. He emphasized its importance in both peace and war and expressed the opinion that the \$9,500,000 would prove to be a very good investment for the people of the United States.

"The committee was faced with this situation," he told his colleagues. "If we raised the duty on potash undoubtedly it will be carried on to the consumer, but while the consumer is paying this added burden for a few years, I do not say how many, which under the provisions of the bill as introduced was carried only for 5 years, we would be developing an industry in the United States which would operate as a lever at least to preserve our own prices to some extent and to protect them against the possibility in another war of increasing from \$40 to \$100 per ton."

GERMAN-ALSATIAN COMBINE

Senator Smoot of Utah laid before the Senate the contracts which American purchasers were compelled to sign in order to secure German and French

potash. The contracts show that Germany and France have agreed on this form of contract and have decided to permit Germany to take 75 per cent of all American orders, while the French producers are to fill the remaining 25 per cent. This led Senator Reed to remark that France and Germany have no difficulty in getting together when it is a case of "skinning" America in a commercial transaction.

LENROOT LEADS OPPOSITION

The committee failed to explain to the satisfaction of the Senate why the bounty policy, if applied to potash, should not be applied to manganese, tungsten and other products of which the domestic production can supply at best only a small percentage of the country's requirements.

Senator Lenroot of Wisconsin expressed the hope that the Senate would not "embark upon the sea of bounties." "If it does," he said, "and the door be opened, as is proposed by the committee, the Treasury of the United States will have to be enlarged, because there will be demands for bounties from every quarter. If the precedent be set here today, we will have in the future pork-barrel bills composed of bounties compared to which river and harbor bills will seem as nothing. I am amazed that this committee, which has under its care the protection of the Treasury of the United States, should bring to the Senate such a proposition as this."

"If the farmer is not sufficiently interested, why does the chairman think the people of the United States as a whole are willing to do what the farmer himself is not willing to do?" he inquired.

NEBRASKA DEPOSITS SUFFICIENT FOR ONLY 10 YEARS

The Wisconsin Senator quoted from the Tariff Commission's report to show that the Nebraska deposits will be exhausted in 10 years. He said Nebraska would absorb 50 per cent of the bounty for an industry that would have to go out of business anyway in 10 years. He suggested that it would be better insurance for another war not to exhaust the Nebraska potash. Outside of Nebraska, he said, the \$9,500,000 would go to three or four companies only. In addition to the question of policy, he pointed to opinions

Arsenic Goes on Free List as Essential to Boll Weevil Control

White arsenic and arsenious acid were put on the tariff bill's free list on Aug. 8 when the Senate, by a vote of 29 to 25, struck out the amendment of the Finance Committee, proposing to make each commodity dutiable at the rate of 2 cents per pound. The amendment, which overrode the Finance Committee, was offered by Senator Smith of South Carolina. His principal argument in support of his amendment was that arsenic is the basis of insect control and is essential to agriculture. He presented a report from an agent of the Department of Agriculture in which it was stated that great difficulty is being experienced in securing calcium arsenate.

of the Supreme Court which he interprets as an indication that a bounty is unconstitutional.

BOUNTY AS AID TO AGRICULTURE

Senator Smoot, supporting the bounty, urged the Senate to free American agriculture from the clutches of two powerful syndicates, one in Germany and the other in France, "both working in complete harmony in the control of the potash of the world." He said the German potash syndicate is back of the propaganda designed to influence American farmers against the use of American potash.

Senator Reed said that it is intolerable that American concerns be permitted to sign such contracts with foreign producers. "That is a trust practice in its worst form," said the Missouri Senator. "My judgment is that any American manufacturer who will do it ought to be sent to jail for a long term."

Senator Simmons of North Carolina predicted that with so large a bounty enough potash would be made to require the payment of many times \$9,500,000. "At the end of 5 years," he asserted, "if that bounty be withdrawn, the industry will go to pieces in the face of this same foreign competition. It is impossible for us to make in the United States by expensive processes a potash that can be sold in competition with the potash that is found abroad in inexhaustible quantities and needs only to be dug up, as we would dig up sand."

American Peat Society Plans Annual Meeting

The American Peat Society will hold its sixteenth annual convention at South Bend, Ind., Aug. 29 to 31. The activities of this society are devoted to the diffusion of knowledge concerning the farming of peat and muck and it is made up of men from all parts of the United States and Canada.

The program will extend over 3 days and will cover many phases of intensive agriculture and peat and muck utilization. Papers illustrated by lantern slides of interest to intelligent practical farmers and persons concerned with fuel will be presented by representatives of the Departments of Agriculture, Commerce and Interior, by representatives of state agricultural and geological institutions and by private professional and business men. Excursions will be made to experimental plants near South Bend.

There are 12,000 square miles of muck and peat land in the Great Lake and New England States that can be used for the production of truck and general farm crops, fertilizer and fuel. Fourteen billion tons of fertilizer or fuel is available. The fertilizer is worth \$10 per ton and the fuel can be produced for \$1.50. In some parts of the country the proceeds from the cultivation of muck soils amount to over \$500 per acre per year.

Among the papers to be presented are the following:

"Peat Resources of the United States," by C. C. Osborn, formerly in charge of peat investigations for U. S. Geological Survey.

"Technologic Aspects of Peat," by a representative of the Bureau of Mines.

"Peat Fuel Industry of Foreign Countries," by a representative of Department of Commerce.

"Classification of Peat and Muck Soils," by Milton Whitney, chief U. S. Bureau of Soils.

"Peat as a Fertilizer Ingredient," by Fred Wiedmer, president Wiedmer Chemical Co.

Cellulose Section, A.C.S., Plans Symposiums

The cellulose section of the American Chemical Society is arranging for two symposiums to be held at the time of the Pittsburgh meeting. The subjects—"The Constitution of Wood Cellulose" and "The Adsorption of Salts by Cellulose"—should prove of particular interest to pulp, paper and textile chemists. Among other scheduled speakers are Professors Bancroft, Holmes and Wise, and Doctors Johnson, Hawley, Esselen, Rue, Sherrard and Tingle.

Papers which are likely to arouse much interest and discussion are one by E. Sutermeister on "Research Problems in the Paper and Pulp Industry," and two by Alfred Tingle on "The Process in the Beating Engine and at the Wet End of the Paper Machine," and "The Reaction Between Aluminum Sulphate and Rosin-Size Solutions."

American Valuation Adopted for Dyes

Senate Accepts Flexible Tariff Proposal as Substitute for Embargo

American valuation as a basis for the application of import duties on coal-tar dyes and chemicals covered in sections 25 and 26 of the chemical schedule of the tariff bill was adopted by the Senate Aug. 11, without a record vote. Under the provisions of this so-called elastic tariff, the President has the power to transfer the basis of evaluation of these chemicals from foreign to American valuation, which is equivalent to an increase of more than 50 per cent of the duties in some cases.

It is provided that the President shall consider the difference in the wholesale selling prices of domestic and foreign merchandise in the principal markets of the United States, in ascertaining the difference in the costs of production here and abroad. The President is also directed to take into consideration the "advantages granted to a foreign producer by a foreign government or by a person, partnership, corporation or association in a foreign country." Senator Walsh of Montana declared that it would not be possible to obtain information as to wages, cost of raw materials and other items of production costs for the foreign products and offered a motion to strike out the whole paragraph. The motion was defeated by a vote of 42 to 20. Senator Smoot of Utah, a member of the Finance Committee, also acknowledged the difficulty of fixing the duties on patented products under the chemical schedule. "In fact," he said, "it is an utter impossibility to find the cost of production. In such a case, the only thing to do is to use the plan as outlined by the committee and get as near to the production cost as possible." He intimated that the determination of costs might be carried into the courts.

A SUBSTITUTE FOR THE EMBARGO

Senator McCumber, chairman of the Finance Committee, explained that the subdivision of section 315 covering the flexible tariff provision was intended to apply more specifically to dyes. "This method of meeting certain specified cases—not specified in the bill, but well understood by the Finance Committee—was in the first instance to prevent the necessity of continuing an embargo," said the North Dakota Senator. "It was intended to cover some of the chemicals and dyestuffs which might require a greater expansion of the duties than would be provided by increased duties on the foreign valuation basis.

"Of course, we have voted out the embargo proposition entirely and we have left the bill in such shape that it would be impossible to maintain an industry that we regard essential under the general rule which is provided in this amendment. That was the real purpose. It may be that the President might abuse that purpose. I do not think we will nor that anyone else will."

Chemistry Part of Curriculum of Every Course at Penn State

A course in chemistry is a requirement in all the schools of the Pennsylvania State College, according to an announcement made at that institution recently. For most of the professions for which the college offers training, a considerable knowledge of chemistry is necessary.

In the school of agriculture, general chemistry, agricultural chemistry, physiological chemistry, food chemistry, soil and fertilizer analysis, dairy chemistry, the chemistry of milling, and the chemistry of forest products, are among the courses given. In the school of engineering, among the courses offered are general chemistry, the chemistry of sanitation, electrochemistry, industrial chemistry, and a course in carbon compounds. In the school of liberal arts only a course in general chemistry is required, though others may be elected. In addition to the general chemistry required in the school of mines, physical chemistry and other courses bearing on the subject of mining are given. Chemistry, of course, plays the most important part in the curriculum of the school of natural science. Household chemistry and the chemistry of food and nutrition are given for the department of home economics.

Bureau of Standards Announces New Samples and Renewals

A new standard sample of tin-base bearing metal No. 54 is now being issued by the Bureau of Standards, with a provisional certificate. This sample has the approximate composition: tin 88 per cent, antimony 7 per cent and copper 4 per cent. In addition, it contains small amounts of lead, iron, bismuth and arsenic. The price of this sample per 140 grams is \$2 prepaid or parcel post C.O.D.

Benzoic acid No. 48a and benzoic acid No. 39a have been discontinued. Benzoic acid No. 39b replaces both of these and is issued for use both in acidimetric and calorimetric work. The price of this sample is \$2 per 30 grams.

The following renewals are also ready for distribution at the price of \$2 per 150 grams: Renewal No. 14b of basic 0.8 per cent C steel No. 14a; renewal No. 19b of acid 0.2 per cent C steel No. 19a; renewal No. 20b of acid 0.4 per cent C steel No. 20a.

Sodium Nitrate Barge Fire Endangers Ships and Stores

Several ships and large quantities of merchandise were endangered by the burning of a lighter loaded with sodium nitrate in Erie Basin, New York City, Aug. 11. The lighter was being loaded with the saltpeter from the United States Shipping Board freighter West Jaffrey when the fire broke out. The crew attempted to extinguish the flames with a hastily formed bucket brigade, but were forced to abandon the lighter and cast her off from the freight vessel. Shortly after the barge was abandoned an explosion occurred which sank it.

Fraud Alleged in Salvage Deal for Old Hickory Powder Plant

Former Director of Sales of War Department and Business Men Indicted on Charge of Bid Containing "Joker"—Defendants Protest Innocence and Charge Politics

AN INDICTMENT has been returned by the special Grand Jury charging conspiracy in connection with the disposal of the Old Hickory Powder Plant at Jacksonville, Tenn. The indictment alleges that by an unlawful conspiracy among the three defendants, they participated in the sale and purchase of the plant for about \$1,000,000 less than other bidders offered.

LARGEST SMOKELESS PLANT

It will be recalled that the Old Hickory plant, the largest smokeless powder plant in the world, was erected for the government in 1918 by the du Pont Engineering Co. At the time of the armistice the plant was producing over 500,000 lb. of smokeless powder per day. It may also be remembered that a mild sensation was caused about two years ago by the theft of some of the platinum contact mass which was being recovered from the dismantled sulphuric acid units.

The plant was sold to the Nashville Industrial Corporation by the government. This corporation was organized by Ernest C. Morse, former director of sales for the War Department, said to be at present in Poland on business for the Foreign Export Supply Company, and Everly M. Davis and Alexander W. Phillips, trading under the name of the E. M. Davis Chemical Company of New York.

CHARGE "TRICK" BID

The method by which the defendants are alleged to have conspired to defraud the government is in the bid sent in by Davis and Phillips. It is charged that this bid contained many reservations and deductions which tended to make it appear that these two defendants were offering more for the plant than they actually offered. This so-called "trick" bid, the indictment charges, was, through Morse as sales director, approved by Secretary of War Baker on Oct. 9, 1920.

The contention of the government is that had it not been for the alleged unlawful acts of the defendants, the sale would have brought \$4,700,000. The indictment has nothing to do with the sale of about \$5,000,000 worth of surplus property at the plant which was disposed of before the plant itself was put on the market.

OUTRAGE, SAYS DAVIS

Everly M. Davis, who claims to have been instrumental in bringing together certain business and financial interests in Nashville, Denver and New York for the purpose of purchasing the plant, is emphatic in his denial that there was anything criminal or even improper in the transaction. He accuses the government of making him and his

associates the scapegoats in an attempt to impress the public with the results of its war fraud investigation.

"These indictments are an abominable outrage," said Mr. Davis. "There is no reason why I should be indicted. What we did was perfectly clean."

"As soon as I have a chance to read the indictment and see exactly what I am charged with I will make a statement giving the facts of the transaction in question, for I believe the public should know the facts. An important public question of national interest is involved, in my opinion, and I think it will be interesting for the public to know how these so-called war frauds are being investigated."

DENIES BID HAD "JOKER"

Mr. Davis declares that the bid which was accepted by the government and which is now denounced as intentionally misleading was the result of painstaking efforts on the part of himself and capable associates. "It was our idea," he says to leave nothing to chance. We made our bid complete to the smallest detail."

As is well known, the government had already sold and contracted for the sale of a considerable quantity of the Old Hickory equipment and Mr. Davis claims that his bid very carefully stipulated that the returns from this property were to be deducted from the lump sum which was offered for the whole plant. "In other words," said Mr. Davis, "we did not want to buy a cat in a bag so we protected ourselves in the provisions of our offer. That is the grounds for calling ours a 'trick' bid."

SAYS TESTIMONY WAS REFUSED

Mr. Davis states that when he learned that the case was under investigation and that witnesses were being examined about it, he wired the District Attorney asking to be permitted to go before the Grand Jury and offering to waive immunity. Mr. Phillips did the same thing. This request was refused. They then asked the District Attorney for an opportunity to state the facts to him personally for any use he wished to make of them. This was likewise refused.

"From the unwillingness to hear the other side," says Mr. Davis, "the conclusion would seem to be unavoidable that the representatives of the government charged with making this investigation are more concerned with the obtaining of this indictment at this time than in establishing the truth; more interested in being able to emphasize to the public the fact that an indictment has been brought than in knowing themselves whether they have a proper basis on which to indict."

Government Action Against Foundation Proceeds Slowly

That the Attorney General has encountered more obstacles than he anticipated in his proceeding against the Chemical Foundation was indicated on Aug. 10, when in explaining the delay in filing the suits, he remarked facetiously that he is confronted in the Chemical Foundation matter with a "powerful combination of self-constituted and indefatigable philanthropists." Mr. Daugherty stated that he personally devoted three intensive hours on the bill of equity on Aug. 9. He did not say when the suit would be filed, but declared that the department was making haste slowly.

The office of the Alien Property Custodian is furnishing the Department of Justice detailed data on each of the patents, and it is estimated that in all they will cover at least seven thousand pages.

Since the administration's effort to secure the return of the patents several attempts have been made to obtain an expression from the National Research Council as to whether or not the Foundation has lived up to that portion of its charter that provides that the free net earnings of the corporation above 6 per cent are to be "used and devoted to the development and advancement of chemistry and allied sciences in the useful arts and manufactures in the United States."

The position of such officers of the Council as are in Washington is that this is a matter for the Interim Committee of the Council to pass. The Interim Committee will not meet until some time in September.

Chicago Section of A.C.S. Enters Plea for Dye Embargo

The executive committee and the councilors of the Chicago Section of the American Chemical Society have sent a telegram to the two Illinois Senators, McCormick and McKinley, urging them to support the proposed embargo on dyes. The telegram reads:

Chicago Section American Chemical Society is thoroughly convinced that dye embargo is absolutely necessary for proper development of chemical industries and that it is to the decided advantage of American users of chemicals. Before it is too late we urge you to reopen the matter and do your utmost in action and support for the embargo.

The signers of the telegram included some of the most distinguished scientists in the West. Dr. Leech, chairman of the section, commenting upon the telegram, said that the executive committee and the councilors of the Chicago group of chemists feel that the interests, first, of public health demand the establishment of an organic chemical industry, which is "only possible if German unfairness is barred at our shores; second, national security and third, the economic returns and benefits from having our own industry and being free from a foreign monopoly."

Ellis Oil-Cracking Patents Subject of Suit

**Standard Oil of New Jersey Charges
Infringement in Cross Process
of the Pure Oil Co.**

The Standard Oil Co. of New Jersey has brought suit in the U. S. District Court, Southern District of Ohio, against the Pure Oil Co. of New York in order to restrain an alleged infringement of the Ellis patents for the cracking of petroleum distillates. The latter company is claimed to have been engaged in cracking oil at its plant at Heath, Ohio, under the Cross patents, which are controlled by the Gasoline Products Co., of 52 Broadway, New York City. The Standard Oil Co. claims that this process is an infringement on its so-called tube and tank method of oil cracking, which is broadly covered by the Ellis patents of 1913.

That the litigation may prove of considerable consequence to the petroleum industry is indicated by a statement from the Gasoline Products Co., which by agreement with the defendant is to bear the expenses of the suit. Officials of that company declared that the validity of the Cross patents had been passed on by some of the country's foremost patent authorities and that subsequently the process had been adopted by several of the independent refineries. The suit they believed to be nothing more than an attempt to hamper independent gasoline production.

DENY MONOPOLISTIC CONTROL

The existence of any monopolistic control of cracking processes was immediately denied by the Standard company, which indicated that it was willing at all times to grant licenses under these patents. Its statement, in part, follows:

It is not to be understood that the bringing of this suit indicates any intention or desire on the part of the Standard Oil Co. of New Jersey to monopolize the use of cracking processes of the type in question. The suit was deemed to be necessitated by the fact that certain interests in the oil industry have been persuaded to refuse to respect the rights vested in this company by the grant of the broad Ellis patents. Under the circumstances, this company felt compelled to seek legal redress.

With regard to that considerable proportion of the industry which has evidenced that it intends to respect our patent rights, there is no disposition on the part of the company to maintain a monopoly of the use of the type of process in question or to impose burdensome or discriminatory terms of license. The company is and has been, willing to grant licenses under its cracking patents on fair and reasonable terms.

OUTLINE OF CROSS PROCESS

The operation of the Cross process embraces the following features:

1. Heat is applied to the oil in tubes arranged in series. The tubes are placed horizontally in a heavily constructed, well-insulated furnace in such manner that should a tube fail the only damage is from loss of the tube, as the small amount of oil discharged is burned and mostly goes up the chimney or is discharged into a tank.
2. The oil is pumped through the tubes in one direction only and no oil that has undergone reaction with the

separation of carbon is returned to the tubes.

3. Decomposition does not take place in the tubes sufficiently to deposit an appreciable amount of carbon.

4. The heated oil is passed from the tubes to a reaction chamber, where conversion of the heavy oil into gasoline takes place and where the carbon is deposited.

5. No heat is applied to the reaction chamber, but this chamber as well as all parts of the plant are heavily insulated against losses of heat to the atmosphere.

6. No distillation takes place from the reaction chamber or from any portion of the system, as this would retard the conversion by reason of its cooling effect.

Both processes are claimed to be particularly well adapted for use by the small refiner, since capacity and outlay for equipment are much less than for the better known Burton process.

Organic Chemical Manufacturers Pledge Support to New Chemical Division

That the chemical industry has already recognized the new Chemical Division of the Department of Commerce as a valuable aid to business is shown by the support accorded to C. R. DeLong, its recently appointed chief. Several representative organizations have offered their assistance in organizing and carrying on the work.

On Aug. 3 Charles H. Herty, president of the Synthetic Organic Chemical Manufacturers' Association of the United States, pledged the whole-hearted support of the seventy-seven member firms of that organization. Furthermore he testified as to the value of the monthly statistics being compiled by the bureau and offered to assist in their dissemination while the work of organization is still under way. Dr. Herty's letter to Mr. De Long in part reads as follows:

On behalf of the seventy-seven member firms of this organization I want to tender our whole-hearted support in the work of building up this division of the bureau, which I am confident will be of unlimited value in the development of the organic chemical industry in this country.

Among the valuable pieces of information issued by the bureau in the past have been the monthly bulletins of statistics on imports and exports of dyes. Our manufacturers are very anxious to receive this information regularly and it occurs to me that while your work of organization is under way we could distribute this information to our members from this office if that were agreeable to you, later turning over our mailing list to your division so that the matter could go direct to our members.

The letter expressed the further hope that it would be possible to extend the statistical service to cover all synthetic organic chemicals.

Liquid Oxygen as an Explosive

Such promising results have been obtained in the course of the experiments conducted by the Bureau of Mines in the use of liquid oxygen as an explosive that there is a widespread demand for further work along the same line. The demand is coming largely from the building and city improvement industries where there is need for an explosive possessing the minimum handling hazard.

Engineers Advocate National Hydraulic Laboratory

**Would Create Facilities for Study of
Problems of Water Supply
and Flood Control**

A national hydraulic laboratory, in which studies relative to the country's problems of water supply and flood control would be carried out, is to be advocated by Mortimer E. Cooley, president of the American Society of Civil Engineers, before a Senate sub-committee the latter part of this month.

A bill to create such a laboratory is now before the Senate. The sub-committee is composed of Senator Ransdell of Louisiana, Senator du Pont of Delaware and Senator McNary of Oregon, representing the Gulf, Atlantic and Pacific coasts. Dean Cooley and J. R. Freeman, of Providence, R. I., will make the initial presentation of the case for the laboratory, contending in behalf of the engineering profession and other national agencies that the laboratory would make it possible to concentrate attention on the scientific side of flood control and other hydraulic problems. Mr. Freeman is a national authority on water power and a year ago, as a member of the John Fritz Medal Board deputation, studied at first hand the power situation in European countries, particularly France.

At the last meeting of the executive board of the American Engineering Council, the Council's committee on water power, of which Colonel J. H. Finney of Washington is chairman, was directed to place before President Harding the facts of the situation with regard to water-power development in this country. The board's action, it was stated, was prompted by "the Federal Water Power Commission's lack of effective and permanent personnel." The water-power plan coincides with the American Engineering Council's reforestation movement, in which the engineers are co-operating with the U. S. Forestry Service, the Forestry Services of the states, universities and technical schools, and other groups such as farmers, railroads, the movies and lumbermen to conserve the country's forests.

The executive board of the Council, which is to meet in Boston, Sept. 8 and 9, has adopted a resolution declaring that stream flow conditions in many sections of the country vitally affect the welfare of the people in many ways. Loss of life and property damage resulting from floods, economic significance of water-power developments, industrial utilization, quantity, quality and possible contamination of municipal supplies, and interstate subsurface water supply were some of the ways by which, it was declared, grave problems are arising.

Dean Cooley, who has been holding a series of conferences with engineering leaders in New York, said that the whole question would come before the executive board of the Council in Boston next month.

Technical Photographic Society Announces Exposition Program

Preliminary announcement has been made of the program and exhibition plans of the Technical Photographic and Microscopical Society. In addition to other features of the program of interest to the technical photographer and microscopist as an adjunct of chemistry, the following papers have been scheduled:

"The Photomicroscopy of Paint and Rubber Pigments," by Henry Green of the New Jersey Zinc Company, Palmerton, Pa.

"Photomicrography in Pulp and Paper Research Problems," by Miss Eloise Gerry and Dr. E. M. Diemer of the Forest Products Laboratory, Madison, Wis.

"Handling of Motion Picture Films," by Dominic S. Mungillo of the Craftsmen's Film Laboratory, New York.

"Mechanics of Motion Picture Apparatus," by Clarence W. Gibbs of the Victor Animatograph Company, New York.

"The Motion Picture as an Art in Industry," by Alfred B. Hitchins, director of the Ansco Research Laboratory, Ansco Company, Binghamton, N. Y.

"Microscopy in Leather Tanning," by Guido E. Daub of A. F. Gallun Sons Company, Milwaukee, Wis.

"The Use of the Microscope in Textile Work," by Albert H. Grimshaw, of the Textile School, New Bedford, Mass.

"Protozoa and Rotifers: Studies in Microscopic Animal Life," by Philip O. Gravelle, South Orange, N. J. This paper will be illustrated with motion pictures.

In addition to the meeting sessions of the society at the Exposition, the organization will have an exhibit at which the advance in technical photography, microscopy, and in chemistry as a result of these two sciences, will be demonstrated. Many of the problems of the chemical consuming industries, particularly regarding the physical nature of raw materials and finished products, have received the attention of a number of members of the society and can be discussed with the investigators at the Exposition.

Will Establish Engineering Museum

Plans for the establishment of a national engineering museum, the first of the kind in the United States, are announced by the American Society of Mechanical Engineers. The collection, which will be part of the Smithsonian Institution's National Museum at Washington, will be started with various models, drawings, diplomas and medals that once belonged to Captain John Ericsson and Cornelius H. DeLamater, builders of the Monitor, and the pioneer engineers of America.

All the engineering societies in America have accepted the Mechanical Engineering Society's invitation to participate in assembling material for the museum.

Fire Prevention Exposition Planned in New York

Loss of \$1,300,000 Daily by Fire Arouses Organizations to Educational Steps

Manufacturers of fire-resistive materials and of fire fighting and retarding apparatus will have the opportunity of taking part in a Fire Prevention Exposition to be held Oct. 2 to 7 at the Twenty-second Regiment Armory, New York City, where will be shown, by exhibit and demonstration, the vital part in the fight against the great annual fire loss played by fire-safe materials and apparatus.

The Exposition originated with the fire prevention committee of the National Association of Insurance Agents as part of its program of fire prevention activities. It has been endorsed by the National Fire Protection Association, the National Association of Credit Men, the International Association of Fire Engineers, the National Board of Fire Underwriters and other associations.

The problem of reducing the terrific strain on business caused by preventable fires that seem to be increasing each year is one that has engaged the attention of these organizations. At the present rate of burning, property worth \$1,300,000 is being destroyed each day. So great has the strain on business become that on June 26, at the request of these organizations, Governor Ritchie, of Maryland, called a conference of the Governors of New York, New Jersey, Maryland and Virginia. This conference adopted a motion to present the matter of fire waste and conservation to the Chamber of Commerce of the United States and on July 12 a conference of representatives of the four associations named above and of the American Institute of Electrical Engineers, Railway Fire Protective Association, American Institute of Architects, American Society of Mechanical Engineers and the Boy Scouts of America was held at Washington. The Chamber of Commerce of the United States was asked to undertake the responsibility of educating organized business men to the huge annual tax caused by fires. The Chamber accepted this responsibility and plans are now under way for a national citizens' fire prevention campaign.

The peak of this year's effort will be reached during National Fire Prevention Week, Oct. 2 to 7, and the First Fire Prevention Exposition will be its greatest educational feature. It is proposed to show the latest ideas in fire-safe construction and also to demonstrate to the public the proper appliances to be used in fighting and preventing fires.

A lecture hall is in the armory building and it is planned to make each day of the Exposition a special day, with lectures and motion pictures in the lecture hall. A. E. MacKinnon, of 405 Lexington Avenue, New York, is chairman of the exposition committee.

Alpha Chi Sigma Members Will Register at Exposition

Members of Alpha Chi Sigma, the national chemical fraternity, who attend the Exposition of Chemical Industries in New York, Sept. 11 to 16, are invited to register at the booth occupied by *Chemical & Metallurgical Engineering*. The dinner which is planned for Thursday evening of that week will attract a number of members who will be in town for the Exposition. In order that arrangements may be made all members are requested to sign up in the register that will be available for that purpose at the *Chem. & Met.* headquarters on the first floor of the Grand Central Palace.

Meat-Packers Deny Control of Tanning Industry

Denying the charge that the tanning industry is controlled by powerful meat-packers, and resenting the inference that the meat-packers would destroy competition, the Institute of American Meat Packers has issued the following statement:

"The Institute of American Meat Packers is not concerned one way or the other in the proposed tariff or the absence of a tariff on hides but is very much interested in remarks about the packing industry made by Senator Walsh and published throughout the United States. Senator Walsh said that the big packers virtually control the tanning industry and that if there was a duty the small tanners would be driven out of business. This statement is erroneous; the packers big or small do not have any control of the tanning industry. The big packers, through tanneries in which they are interested both directly and indirectly, handle less than twenty per cent of the leather made in the United States and they are in keen competition with each other even in the handling of this small proportion.

"If there should be a duty on hides and this duty raised their price, the competition among the packers would result in passing the benefit along to cattle raisers. The effect would be slight, it is true, but cattle values fluctuate 5 and 10 cents per hundred-weight at a time depending on the value of the meat and byproducts. Hence a slight increase in hide values would result in a slight increase in cattle prices and a proportionate increase in cost to the consumer. Competition keeps the packers' profit at a minimum. It is therefore unfair to say that small tanners will be squeezed out.

"The Institute resents any inferences that the packing companies could or would crush or destroy any industry. The charges that the packers have a monopoly power over the price of cattle, hides, meat or other products have been disproved again and again. This statement is issued not so much in criticism of Senator Walsh as it is to correct published inferences which reflect upon the commercial integrity of one of America's most important industries."

Pyrene Fire Extinguishers Reported Safe in Subway

New York Transit Commission
Exonerates Tetrachloride in
Recent Accident

After an investigation of the circumstances attending the fire in the New York subway some weeks ago, the Transit Commission has reported that all the illness and suffering of passengers was caused by smoke from burning insulation aggravated by the panic and haste with which they climbed 75 feet to the street, and that no serious amount of poisonous gases was generated by the Pyrene fire extinguishers. What fumes did come from the carbon tetrachloride used in the extinguishers were so diluted as to be negligible.

In preparing this report the commission had the services of experts from the Bureau of Mines and of consulting electrical engineers. The results of their investigations are summed up as follows:

There were apparently no really serious cases resulting from the effects of possible toxic gases.

The symptoms given in the hospital records can all be accounted for by the known effects of gases resulting from the burning of insulating materials, rubber, varnish and paint.

The symptoms are not characteristic of phosgene or tetrachloride poisoning.

The report calls attention to the work of the Materials Inspection Division of the commission in connection with the Bureau of Mines, which points out that Pyrene is particularly adapted to fires produced by electric short circuits because it is not a conductor. After stating that experiments will be made to find a better extinguisher, the report says:

"In the meantime our study of the results of the use of Pyrene in this instance conclusively shows that its use was in no way dangerous or even discommoding. The continued efficient operation of the subways is essential to the life of the city, and this efficient operation requires the use of some immediately available fire extinguisher in case of electric short circuits, which are always possible of recurrence. Tetrachloride is the best known and most universally accepted extinguisher for this purpose. Nothing has been discovered by the investigation to justify ordering its discontinuance."

Walter Bauer, president of the Pyrene Manufacturing Co. has asked the Transit Commission, President Frank Hedley of the Interborough, and Mayor Hylan to permit a public demonstration of the efficiency of the Pyrene fire extinguisher.

Civil Service Wants Food Chemist

The United States Civil Service Commission announces an open competitive examination for assistant chemist in the chemistry and physics of food preparation under the Department of Agriculture. The entrance salary will range between \$1,980 and \$2,400 a year.

Non-Metal Industries Appeal for Government Research Funds

Members of Congress from the states having deposits of the non-metallic minerals are receiving many letters urging that Congress provide money for certain fundamental statistical and research work in connection with the non-metals industries. Since the government is conducting such work in connection with many other industries, those interested in the non-metals feel that proper recognition has not been accorded them.

During the last fiscal year, the Bureau of Mines appropriation carried an item of \$35,000 for work in the non-metals. The item was eliminated from the appropriations for the current fiscal year. Realizing that steps to secure an appropriation for the fiscal year beginning July 1, 1923, must be taken long in advance, the industries concerned with the non-metals are agitating the matter thus early in the hope that Congress may be so impressed that at least the \$35,000 item will be inserted in the appropriation bill covering expenditures during the next fiscal year. There is a demand for statistics and research covering such minerals as clay, granite, trap rock, chalk, emery, corundum, garnet, phosphate rock, sulphur, mica, asbestos, limestone, molding sand, glass-sand, dolomite, barium, graphite, gypsum, and slate.

Personal

EDWARD F. BEALE, president of the John T. Lewis & Bro. Co., Philadelphia, Pa., manufacturer of paints, colors, oils etc., has been elected vice-president of the National Lead Co.

GEORGE T. BRISTOL, who has been with E. I. du Pont de Nemours & Co. for the past 10 years, specializing in matters pertaining to Fabrikoid, has been appointed manager of the company's Fabrikoid plant at Newburgh, N. Y.

H. A. BROWN, assistant sales manager of the trade sales division, paint department, of E. I. du Pont de Nemours & Co., has just returned from a 4 weeks' trip through the South.

L. T. BRYSON has joined the staff of Ivan Jones, Ltd., Calcutta, India, in the capacity of consulting chemist in charge of feed-water treatment.

J. W. COCHRAN has resigned his position with the Wenger-Armstrong Petroleum Co. to become vice-president and director of the Gavin Oil Co., Chicago, Ill.

PHILIP T. DODGE, president of the International Paper Co., and ALLEN CURTIS, vice-president of that organization, sailed recently for a 2 months' tour of Europe. They will visit most of the big paper-making companies while abroad.

Dr. H. D. GIBBS, formerly chief of the Color Laboratory, Bureau of Chem-

istry, has severed his connection with the Jackson Laboratory of E. I. du Pont de Nemours & Co., Wilmington, Del. His plans for the future have not been announced.

WILLIAM J. GRIER, of the North British & Mercantile Insurance Co., Ltd., has accepted the invitation of the officers of the Insurance Society of New York to deliver two lectures on "Chemical Fire Hazards" before the senior class of the Insurance Institute of America on Feb. 15 and March 1, 1923.

Dr. ARMIN R. GROB, formerly a dye-stuff patent expert with the Society of Chemical Industry in Basel, Switzerland, has resigned from E. I. du Pont de Nemours & Co., Wilmington, Del. His plans for the future have not been announced.

Dr. ELLWOOD HENDRICK, consulting editor of *Chem. & Met.*, who sailed on June 10 to attend the meeting of the Society of Chemical Industry in Glasgow, is not expected back until Sept. 2.

Dr. EDWARD C. L. KRESSEL, formerly president of the Active Chemical Co., Camden, N. J., will act in the same capacity with the Consolidated Products Co. of New Jersey, which he has been instrumental in organizing to manufacture a similar line of specialties.

E. W. McCULLOUGH has resigned as director of the division of mining and metallurgy, Republic Creosoting Co., to accept a position as consulting engineer for refuse disposal with the Indianapolis City Sanitary Commission to design and construct a new garbage reduction plant.

J. S. NEGRU, managing editor of *Chem. & Met.*, who has been in Europe for the past 6 months, sailed from Antwerp on Aug. 10. He is expected to arrive in New York about Aug. 18.

Dr. WILLIAM H. NICHOLS, chairman of the board of the General Chemical Co., is to represent the chemical industry on a joint committee composed of members of the Society for the Promotion of Engineering Education and of the National Industrial Conference Board which is planning to take up the general problem of engineering training for the industries. Among others who have been selected to serve on behalf of industry are FREDERICK P. FISH, formerly president of the American Bell Telephone Co. and the American Telephone & Telegraph Co.; E. M. HERR, president of the Westinghouse Air Brake Co. and of the Westinghouse Electric & Manufacturing Co., and HENRY D. SHARPE, treasurer of the Brown & Sharpe Manufacturing Co. Dr. F. W. McNAIR, president of the Michigan College of Mines, has been appointed to represent the Society for the Promotion of Engineering Education. Other educators will be chosen from technical schools of the country.

WALTER C. TEAGLE, president of the Standard Oil Co. of New Jersey, New York City, has returned from a trip to Europe.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Marketing Problems of the Sulphur Industry*

Production, Consumption and Distribution of a Raw Material for Many Important Industries—Price Range and Trend Toward Enlarging the Market

By ALBERT G. WOLF
Texas Gulf Sulphur Co.

MORE THAN 99 per cent of the sulphur mined in the United States and 75 per cent of the world's production comes from three mines on the Gulf coast. In the order of their present and probable future importance as sulphur producers these are the Texas Gulf Sulphur Co., Matagorda County, Tex.; the Union Sulphur Co., Calcasieu Parish, La.; and the Freeport Sulphur Co., Brazoria, Tex. These three mines supply practically all the sulphur used in this country. In this article the word "sulphur" is used to designate crude sulphur or brimstone, and not sulphur produced from sulphides of metals. Wherever tons are mentioned in connection with sulphur the unit of weight is the long ton or 2,240 lb.

USES OF SULPHUR ARE MANY

It is no exaggeration to say that sulphur is a constituent of, or a necessary reagent in, the manufacture of a large proportion of the articles in common use today.

The list in Table I, though probably far from complete, gives a good idea of the multiplicity of specific uses of sulphur. Every item either contains sulphur or requires sulphur in its manufacture.

The industries that use sulphur most are those which burn it to form sulphur dioxide, and employ that gas in their operations. These account for 75 per cent of the sulphur consumption in

Editor's Note.—This article is abstracted from one of an important series on the marketing of minerals which is now appearing in the *Engineering & Mining Journal-Press*.

TABLE I—LIST OF PRODUCTS IN THE MANUFACTURE OF WHICH SULPHUR IS REQUIRED

Acids	Hose
Alum	Insecticides
Aniline	Leather
Artificial silk	Livestock food
Belting	Lubricating oils
Binding medium	Matches
Bleaching materials	Medicine
Celluloid	Paints
Cements	Paper
Chemicals	Photo supplies
Dyes	Plastic (wood pulp)
Ebonite	Poison (rat and other)
Elastics	Preservative for food
Explosives	Reagents, laboratory
Fabrics	Rubber products
Fertilizers	Shoe polish
Films, moving picture	Soap
Fire extinguishers	Sodium thiosulphate
Fireworks	Steel (pickling)
Fumigating reagents	Storage batteries
Fungicides	Sugar
Gasoline	Textiles
Galvanized iron	Tires
Glue	Weed killer
Glycerine	

this country; the principal ones are the sulphuric acid, paper, chemical, and fertilizer industries.

The industries, in the order of their commercial importance, that purchase sulphur as a "raw material" are:

1. Acid phosphate.
2. Paper.
3. Chemicals (other than sulphuric acid).
4. Sulphuric acid (other than for industries enumerated in this list).
5. Agriculture (other than acid phosphate).
6. Rubber.
7. Galvanizing.
8. Explosives.

This order, of course, is subject to change from time to time; and data for

a more detailed tabulation of the sulphur-using industries are difficult to obtain. Furthermore, some of the industries are so interrelated that it is difficult to segregate the figures of consumption. The manufacture of sulphuric acid, under item 4 above, is by far the most important sulphur-consuming industry in the United States.

GEOGRAPHIC DISTRIBUTION

Sulphur is sold to consumers in almost all the Eastern and Southeastern states, most of the Central, and some of the Western states; likewise in several provinces of Canada and states in Mexico. In the United States, by far the largest proportion is sold east of the Mississippi River. The major buyers may be divided roughly into three groups: The paper manufacturers of the New England states and eastern Canada, the chemical manufacturers of the Eastern states, and the acid phosphate manufacturers of the Southeastern states.

Lesser groups consist of the various industries of the Great Lakes region; the zinc, powder and chemical companies of the Central states; the powder, pulp and spray manufacturers of the Pacific coast; and various industries of British Columbia. Some shipments reach South Africa, the Hawaiian Islands and Australia.

THE MINES ARE THE PRINCIPAL MARKETING POINTS

The primary marketing points are the three mines. From these, shipments are made directly to consumers. Secondary marketing points are the Gulf ports of Galveston, Texas City and Sabine, from which shipments are made to various foreign countries; and the Atlantic coast ports, whence shipments are again made by rail.

In the past the annual consumption of sulphur has been variable. As only 3 years has passed since the war, three

TABLE II—STATISTICS OF SULPHUR PRODUCTION AND CONSUMPTION

Year	Production in Tons			Gross Value	Per Ton Value
	World	United States	Domestic Shipments		
1909	804,690	273,983	258,283	\$4,783,000	\$18.52
1910	775,286	247,060	250,919	4,522,000	18.02
1911	764,358	205,066	253,795	4,573,000	18.02
1912	773,436	287,773	305,390	5,289,000	17.32
1913	793,645	491,080	319,333	5,614,000	17.58
1914	863,143	417,690	341,985	6,214,000	18.17
1915	846,412	520,582	293,803	3,955,000	13.46
1916	1,199,842	649,683	766,835	12,247,000	15.97
1917	1,548,023	1,134,412	1,120,378	23,987,000	21.41
1918	1,655,629	1,353,525	1,266,709	27,868,000	22.00
1919	(a)	1,190,575	678,257	10,252,000	15.12
1920	(a)	1,255,249	1,517,625	(a)	(a)

(a) Statistics not available.

"Chem. & Met." Weighted Index of Chemical Prices

Base = 100 for 1913-14

This week	150.87
Last week	152.08
August, 1921	158
August, 1920	264
April, 1918 (high)	286
April, 1921 (low)	140

Notwithstanding slight advances in the prices for glycerine, caustic soda and linseed oil this index number has continued its downward trend. The decrease in cottonseed oil, which is one of the most sensitive of the index commodities, is principally responsible for the decline.

TABLE III—SULPHUR EXPORTS AND IMPORTS OF THE UNITED STATES

Kind of Imports	1916		1917		1918		1919		1920	
	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value
Crude.....	21,510	\$364,787	973	\$20,176	55	\$1,692	77	\$1,997	46	\$1,722
Flowers.....	425	18,408	.....	.....	.....	.....	.....	.....	.....	.....
Refined.....	455	15,020	.....	.....	.....	.....	.....	15	50	2,530
Precipitated.....	66	12,940	37	9,164	27	7,850	24	6,621	42	22,576
Total.....	22,456	\$404,784	1,010	\$29,340	82	\$9,542	101	\$8,633	138	\$26,828
Exports.....	128,755	\$2,505,857	152,736	\$3,500,819	131,092	\$3,626,638	224,712	\$6,325,552	477,450	\$8,994,350

abnormal years, and as complete statistics are not yet available for 1921, it is difficult to form an estimate of future requirements. It is probably safe to say that the normal consumption in the United States and Canada will be 750,000 tons per year, and by the rest of the world 250,000 tons of sulphur.

YEARLY AND SEASONAL FLUCTUATIONS

The fluctuations in the demand for sulphur are of two kinds, yearly and seasonal. The former is influenced chiefly by general business conditions.

Seasonal fluctuations in demand are not great except in a few industries. The most important of these is the paper-pulp industry. Many of the mills accumulate their supply during the summer months because of the closing of navigation later by ice. Acid-phosphate manufacturers take between 15 per cent and 20 per cent of the total sulphur mined in the United States; as their product is sold largely during the early spring months, their manufacturing season, and consequently their purchasing of sulphur, is most active in the fall and winter months.

PROBLEM IS TO ENLARGE THE MARKET

The great marketing problem of the sulphur producer is to find an outlet for a sufficient tonnage of his product to permit operating at a profit when selling at a price per unit that will make the crude sulphur more desirable than pyrite. The potential production of the domestic mines is 2,500,000 tons per year, whereas the actual production, at present, is not over half that. In the near future the largest annual consumption of American sulphur, both domestic and foreign, that can be expected is approximately 1,000,000 tons.

In addition to this main problem each producing company has its own individual problem in obtaining its share of the sulphur trade without resorting to "cut-throat" tactics, which would lead to the undoing of all of them. The market is not influenced by middlemen, because almost all crude sulphur is sold directly to the consumer.

The one great influence on the price of sulphur, in addition to the general demand, is the price of pyrite. Sulphur is in direct competition with pyrite in the acid-making industry of the United States and Europe and in the paper-pulp industry of the Scandinavian countries. One-half the 1,000,000 tons sold in this country in 1920 was used in sulphuric-acid manufacture. It is possible that sulphur from the United States may replace pyrite to a greater extent than at present in the manufacture of sulphuric acid in Europe.

Table III, from *Mineral Industry*, vol. 29, gives the exports and imports of all classes of sulphur of the United States, and shows clearly that foreign competition has no influence on the price in this country now.

The efficient methods of production which have enabled the American producer to compete successfully with pyrites, both domestic and Spanish, in certain industries, have also made it possible to invade to an increasing extent the European market, formerly supplied entirely by the Sicilian mines.

The New York Market

NEW YORK, Aug. 14, 1922.

The continued shortage of coal has brought about additional changes in the chemical market during the past week. Producers have curtailed production to a considerable extent and the alkali export market for caustic soda was sharply advanced. The domestic price, however, has remained practically unchanged, although the demand has shown a decided improvement. Prices on yellow prussiate of potash were fractionally higher, under a better consuming demand and reduced spot supplies. White powdered arsenic was advanced by leading producers and importers. A large volume of business was reported transacted during the interval. Bichromates of soda and potash have maintained recent advances, and the market is in a very tight position for spot material. White granular sal ammoniac is rather unsettled on spot. The gray variety, however, is exceedingly strong, with domestic factors asking up to 8½c. per lb. Acetate of soda is very firm and several producers report a well sold up condition. Bleaching powder is another item that has shown exceptional improvement and is meriting added interest from the consuming industries. Oxalic acid is being held at the recent advance and buyers are showing an eager desire for available spot goods.

GENERAL AND SPECIAL CHEMICALS

Acetate of Soda—The market is very strong on spot and factors report a well sold up condition. Odd lots range from 6@7½c. per lb., depending upon seller. A much higher market is expected shortly.

Arsenic—Leading producers named higher figures at 8½c. per lb. The consuming demand has been very brisk of late. Shipments from abroad are quoted around 7½c. per lb.

Bleaching Powder—Although prices have not advanced from former levels, the demand continued very strong.

Prices ranged around \$1.60 per 100 lb. f.o.b. works.

Caustic Potash—Material on dock is held around \$5.60 per 100 lb. for the 88-92 per cent. Shipment goods are quoted at 5½c. per lb. c.i.f. New York. The demand is somewhat limited.

Caustic Soda—Export prices were noticeably advanced presumably in order to conserve the supplies for domestic consumption. Spot goods are very limited. The export price is around \$3.65@3.70 per 100 lb. Odd lots for domestic use are held at \$3.75 per 100 lb.

Prussiate of Potash—Quotations were advanced early in the week and spot goods brought 32½c. per lb. Local stocks were reduced considerably.

Prussiate of Soda—Prices during part of the week were up to 21½c. per lb., but later were heard around 20c. per lb.

Sal Ammoniac—Imported white granular was fractionally lower on spot at 6½c. per lb. The gray material was rather scarce and the market was firmly maintained. Domestic producers of gray reported 8½c. per lb. as the general quotation.

VEGETABLE OILS

Linseed Oil—Spot material during the early part of the week was offered as low as 84c. per gal., but was again advanced to 88c. per gal. by leading crushers. The stronger feeling was attributed to the prospects of an early tariff adjustment and a revival of interest from consumers. Imported oil was offered for August shipment at 82c. per gal., present rate of duty, c.i.f. N. Y.

Castor Oil—Producers advanced prices ½c. per lb. on all grades of oil, establishing the market on U.S.P. at 13c. per lb. and the No. 3 grade at 12½c. The advance was due to the higher cost of castor beans. Demand was rather active.

Coconut Oil—Although the market was somewhat unsettled, prices were steady in all quarters, due to the absence of any selling pressure. Resale offerings were not plentiful. Ceylon type oil in barrels was he'd around 8½c. per lb., with the Cochin at 9c. per lb.

Corn Oil—There were offerings of August shipment of the crude at 8½c. per lb., sellers' tanks, f.o.b. Chicago. The demand was of a routine nature.

Peanut Oil—The market for the crude oil was quiet because of the scanty offerings. Mills quote 9@9½c. per lb., crude oil, tank cars for prompt shipment. Refined oil on spot was held around 12c. per lb.

The Chicago Market

CHICAGO, ILL., Aug. 10, 1922.

But little change could be noticed in the local chemical market during the past 10 days. Prices were a little stronger and the inquiry was reported as better, but no one had more business than he could take care of. Incoming freight was being delayed, which doubtless had much to do with the firmer prices, and again, stocks in some quarters were quite limited. An improvement in consumers' business was reported which was not to any extent reflected in the raw material markets. One of the most noteworthy developments is that the buyer is no longer haggling over prices to the extent that he did in the past.

GENERAL CHEMICALS

Caustic soda in the face of short supplies showed signs of firmness. Ground 76 per cent material was available at \$4.35 per 100 lb. and the solid at \$3.80. *Caustic potash* was also very firm, with only moderate supplies on spot at 6½¢ per lb., basis 88-92 per cent. There was a fair inquiry for *soda ash*, and 58 per cent material in single-barrel lots was quoted at \$2.35 per 100 lb. *Sal soda* also enjoyed a fair inquiry and was available at \$1.90.

The movement of alums was reported as slow, with no change in prices. *Potash alum* lump was quoted at 4½¢ per lb. and the powdered at 5½¢ per lb. *Sal ammoniac* was firmer, with supplies lighter than for several weeks. The white granular 98-100 per cent material was quoted by leading interests at 7¼¢ per lb. *White arsenic* displayed signs of firmness and the shortage of supplies forced the price to 8½¢ per lb. *Barium chloride* was available in small or moderate lots at \$100@\$105 per ton. *Copper sulphate* was quite scarce and the price was very firm at 7¢ per lb. *Carbon bisulphide* was also quite firm at 7¢ per lb. *Carbon tetrachloride* moved only in a sluggish way and the price was weak at 9½¢ per lb. *Formaldehyde* showed no change for the better and moved only in a small way at 9¢ per lb. in single barrel lots. *Furfural* was quoted at 35¢ per lb. in thousand-pound lots. *Glycerine* was very firm, and supplies were reported to be moving very well at 16½¢ per lb. for the c.p. material in drums. *Lead acetate* was in poor demand and only small lots moved at 11¢ per lb. *Red phosphorus* moved only in a small way at 25¢ per lb. *Phosphorus pentoxide* was offered at 35¢ per lb.

Bichromates were quoted higher by most holders, although the movement showed no improvement. *Potassium bichromate* was quoted at 11¼¢ per lb., and the soda at 8¼¢ in single-cask lots. *Red prussiate of potash* continued almost unavailable with only very small supplies on spot at 90¢ per lb. *Yellow prussiate of potash* was in fair demand and the price was steady at 32¢ per lb. *Permanganate of potash* moved only in a routine way and supplies of the

U.S.P. small crystals were held at 16¢ per lb.

LINSEED OIL AND TURPENTINE

The movement of *linseed oil* was restricted to small quantities for immediate consumption and nearly all factors predicted lower prices. The boiled oil in single-drum lots was offered today at \$1.02 per gal. and the raw in similar quantities at \$1.

Turpentine was in a position similar to *linseed oil*, with most factors saying that the price was too high and freely predicting a considerable decline. Only small quantities moved to the consuming trade at today's price of \$1.22 per gal. in single-drum lots.

The Iron and Steel Market

PITTSBURGH, Aug. 11, 1922.

Production of steel ingots in July was at an average rate of about 36,000,000 tons a year, against rates of 36,600,000 tons in June, 36,400,000 tons in May and 35,000,000 tons on April 1, when the coal strike started.

Production was not, however, at anything like a uniform rate during June and July. The rate increased toward the close of June, while in the latter part of July it dropped off rather sharply. A fair guess would be that the rate was 37,000,000 tons July 1 and 34,000,000 tons July 31, with a decrease to 30,000,000 tons at present.

KNOWLEDGE OF STEEL CONSUMPTION LACKING

The disposition of market reviewers at a time like this, when industrial operations are restricted by physical causes, is to stress the curtailment in production of the commodity being reviewed and to touch lightly on the curtailment in its consumption. If the reviewer were considering agricultural implements or automobiles, he would probably be full of the idea that production of these articles is hampered by the scarcity of coal. That there is a reduction is already established.

Apart from unconscious bias, facilities are lacking for comparing steel production with steel consumption, because there is more or less definite information as to steel production, while the operation of the thousands of steel consumers throughout the country cannot be viewed. Some information is available to steel mills, though it is not freely disseminated, but even this information is far from representative, because the average consumer, observing that steel is scarce, is disposed to retain or perhaps even increase his stocks. After every period of heavy steel demand there is an unexpectedly heavy liquidation of stocks, during which time demand upon the mills is less than the current consumption.

The present demand for early deliveries of steel products, at premium prices, is not necessarily misleading, but it may mislead through its not being studied on a comparative basis.

Buying for late delivery, practically "delivery at mill convenience," is light

relative to a normal demand, but not particularly light for this time of year. The Steel Corporation's bookings are on the whole rather large. The unfilled tonnage at the end of July is reported at 5,776,161 tons, representing an increase during July of 140,630 tons, equal to 11 per cent of the month's capacity, and as shipments were about 75 per cent of capacity, the total bookings in the month were about 86 per cent of capacity, bookings in previous months, similarly computed, being 103 per cent in June, 86 per cent in May, 115 per cent in April, 90 per cent in March and less than 50 per cent in each of the 17 months preceding, since September, 1920. July bookings of independents were not nearly as heavy as those of the corporation.

The minimum on bars, shapes and plates has advanced from 1.70c. to 1.80c. in the week and from 1.60c. to 1.80c. within 30 days. This is for delivery at mill convenience, technically, though in all probability the convenience of buyer is fairly well met also. Prompt deliveries are up to 2c. or higher. Hoops narrower than 1 in. are now squarely on a base of 2.75c., other hoops remaining on the 2.50c. base. Railroad spikes are up \$2 a ton to 2.35c., while small spikes and boat and barge spikes are up \$5 a ton to 2.75c. Cold-finished steel bars are up \$2 a ton to 2.25c.

POSSIBLE TREND IN THE FUTURE

The condition of the steel market late in the year, when the strikes will have passed into history, will depend largely on the mental attitude of buyers, formed by guesses as to what is to occur industrially in 1923. Nearly all the business for the remainder of the year, in the purchase and sale of mill products, is already done, and the pressure upon mills for deliveries will depend largely upon whether buyers are disposed to hold or increase their stocks or engage in another drastic liquidation such as characterized the year 1921.

All semblance of a forward market in pig iron has disappeared. Buyers would, of course, be very foolish to attempt to make forward purchases at this time, when there is scarcely any merchant pig iron production and when furnaces have no means of knowing when they will be able to get into blast again. The only pig-iron market is a prompt, practically a spot, market, purchases being from stocks, which are meager. Foundry iron is generally bought in single carloads. Natural'y prices have advanced with facility. On the basis of last sales the valley market is quotable as follows: Bessemer, \$27; basic, \$25.50; foundry, \$28; malleable, \$29. Freight to Pittsburgh is \$1.77 since July 1, not \$1.76 as at first computed.

Offerings of Connellsville coke are insufficient to supply anything like a normal foundry demand, not to speak of blast furnace requirements at all. Foundry coke is about \$15, but the price varies considerably with quality.

General Chemicals

Current Wholesale Prices in New York Market

	Carlots F.o.b. N.Y.	Less Carlots F.o.b. N.Y.
Acetic anhydride.....lb.	—	\$0.38 - \$0.40
Acetone.....lb.	\$0.13 - \$0.13	.14 - .14
Acid, acetic, 28 per cent.....100 lbs.	2.60 - 2.65	2.70 - 3.25
Acetic, 56 per cent.....100 lbs.	5.25 - 5.35	5.40 - 5.75
Acetic, glacial, 99 per cent, carboys, 100 lbs.	11.50 - 12.00	12.25 - 12.50
Boric, crystals.....lb.	.11 - .11	.11 - .12
Boric, powder.....lb.	.11 - .11	.11 - .12
Citric.....lb.	—	.45 - .45
Hydrochloric.....100 lb.	1.10 - 1.20	1.25 - 1.70
Hydrofluoric, 52 per cent.....lb.	.11 - .11	.11 - .12
Lactic, 44 per cent tech.....lb.	.09 - .10	.10 - .12
Lactic, 22 per cent tech.....lb.	.04 - .04	.04 - .05
Molybdic, a.p.....lb.	3.00 - 3.25	3.30 - 3.75
Muriatic, 20 deg. (see hydrochloric).....lb.	—	.06 - .07
Nitric, 40 deg.....lb.	.06 - .06	.07 - .07
Nitric, 42 deg.....lb.	.06 - .06	.07 - .07
Oxalic, crystals.....lb.	.15 - .16	.16 - .16
Phosphoric, 50 per cent solution.....lb.	.08 - .08	.08 - .09
Picric.....lb.	.20 - .22	.23 - .27
Pyrogallol, resublimed.....lb.	—	1.65 - 1.75
Sulphuric, 60 deg., tank cars.....ton	9.50 - 10.00	—
Sulphuric, 60 deg., drums.....ton	12.00 - 14.00	—
Sulphuric, 66 deg., tank cars.....ton	14.50 - 15.00	—
Sulphuric, 66 deg., drums.....ton	19.00 - 20.00	20.50 - 21.00
Sulphuric, 66 deg., carboys.....ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	19.00 - 20.00	—
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	22.00 - 22.50	23.00 - 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.....lb.	—	.60 - .75
Tannic (tech.).....lb.	.40 - .45	.46 - .50
Tartaric, imported crystals.....lb.	—	.28 - .29
Tartaric acid, imported, powdered.....lb.	—	.29 - .30
Tartaric acid, domestic.....lb.	—	.30 - .30
Tungstic, per lb. of WO.....lb.	—	1.00 - 1.10
Alcohol, ethyl (Cologne spirit).....gal.	—	4.75 - 4.95
Alcohol, methyl (see methanol).....gal.	—	—
Alcohol, denatured, 188 proof No. 1.....gal.	—	.31 - .33
Alcohol, denatured, 188 proof No. 5.....gal.	—	.31 - .33
Alum, ammonia, lump.....lb.	.03 - .03	.03 - .04
Alum, potash, lump.....lb.	.03 - .03	.03 - .04
Alum, chrome lump.....lb.	.05 - .05	.05 - .06
Aluminum sulphate, commercial.....100 lb.	1.50 - 1.65	1.70 - 2.25
Aluminum sulphate, iron free.....lb.	.02 - .02	.03 - .03
Aqua ammonia, 26 deg. (drums 750 lb.).....lb.	.06 - .07	.07 - .08
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 - .30	.30 - .31
Ammonium carbonate, powder.....lb.	.08 - .08	.08 - .09
Ammonium nitrate.....lb.	.06 - .06	.06 - .07
Amylacetate tech.....gal.	—	2.00 - 2.25
Arsenic, white, powdered.....lb.	.08 - .08	.08 - .09
Arsenic, red, powdered.....lb.	.12 - .12	.12 - .13
Barium carbonate.....ton	61.00 - 63.00	64.00 - 67.00
Barium chloride.....ton	85.00 - 90.00	91.00 - 100.00
Barium dioxide (peroxide).....lb.	.20 - .21	.21 - .22
Barium nitrate.....lb.	.07 - .07	.08 - .08
Barium sulphate (precip.) (blanc fixe).....lb.	.04 - .04	.04 - .04
Blanc fixe, dry.....lb.	.04 - .04	—
Blanc fixe, pulp.....ton	45.00 - 55.00	—
Bleaching powder.....100 lb.	1.60 - 1.75	1.85 - 2.50
Blue vitriol (see copper sulphate).....lb.	—	.06 - .06
Borax.....lb.	.05 - .05	.06 - .06
Brimstone (see sulphur, roll).....lb.	—	.28 - .35
Bromine.....lb.	.27 - .28	.28 - .35
Calcium acetate.....100 lbs.	2.35 - 2.40	2.45 - 2.50
Calcium carbide.....lb.	.04 - .04	.05 - .05
Calcium chloride, fused, lump.....ton	22.00 - 23.00	23.50 - 27.00
Calcium chloride, granulated.....lb.	.01 - .01	.02 - .02
Calcium peroxide.....lb.	—	1.40 - 1.50
Calcium phosphate, tribasic.....lb.	—	.15 - .16
Camphor.....lb.	—	.82 - .84
Carbon bisulphide.....lb.	.06 - .06	.06 - .07
Carbon tetrachloride, drums.....lb.	.09 - .10	.10 - .12
Carbonyl chloride, (phosgene).....lb.	—	.60 - .75
Caustic potash (see potassium hydroxide) Caustic soda (see sodium hydroxide).....lb.	—	—
Chalk, precip.—domestic, light.....lb.	.04 - .04	—
Chalk, precip.—domestic, heavy.....lb.	.03 - .03	—
Chalk, precip.—imported, light.....lb.	.04 - .05	—
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.05 - .05	.05 - .06
Chloroform.....lb.	—	.25 - .32
Cobalt oxide.....lb.	—	2.00 - 2.10
Copperas.....ton	20.00 - 22.00	23.00 - 30.00
Copper carbonate, green precipitate.....lb.	.19 - .20	.20 - .21
Copper cyanide.....lb.	—	.58 - .60
Copper sulphate, crystals.....100 lb.	6.50 - 6.60	6.65 - 7.00
Cream of tartar.....lb.	—	.23 - .25
Epsom salt (see magnesium sulphate).....gal.	—	.65 - .70
Ethyl acetate com. 85%.....gal.	—	.90 - .95
Ethyl acetate, pure (acetic ether, 98% to 100%).....gal.	—	.08 - .09
Formaldehyde, 40 per cent.....lb.	.08 - .08	.08 - .09
Fullers earth, f.o.b. mines.....net ton	16.00 - 17.00	—
Fullers earth—imported powdered—net ton	30.00 - 32.00	—
Fusel oil, ref.....gal.	—	2.25 - 2.65
Fusel oil, crude.....gal.	—	1.45 - 1.50
Glauber's salt (see sodium sulphate).....lb.	—	.16 - .16
Glycerine, a. p. drums extra.....lb.	—	4.20 - 4.25
Iodine, resublimed.....lb.	—	.12 - .18
Iron oxide, red.....lb.	—	.10 - .11
Lead acetate, white crystals.....lb.	—	.13 - .14
Lead arsenate, powd.....lb.	.13 - .13	.15 - .20
Lead nitrate.....lb.	—	.08 - .09
Litharge.....lb.	.07 - .08	.06 - .07
Magnesium carbonate, technical.....lb.	.06 - .06	2.30 - 2.50
Magnesium sulphate, U. S. P.....100 lb.	2.00 - 2.25	1.00 - 1.80
Magnesium sulphate, technical.....100 lb.	—	.57 - .58
Methanol, 95%.....gal.	—	.59 - .60
Methanol, 97%.....gal.	—	.11 - .11
Nickel salt, double.....lb.	—	—

	Carlots F.o.b. N.Y.	Less Carlots F.o.b. N.Y.
Nickel salt, single.....lb.	—	.12 - .12
Phosgene (see carbonyl chloride).....lb.	—	.40 - .45
Phosphorus, red.....lb.	—	.30 - .35
Phosphorus, yellow.....lb.	—	.10 - .11
Potassium bichromate.....lb.	.10 - .10	.17 - .23
Potassium bromide, granular.....lb.	—	.13 - .16
Potassium carbonate, U. S. P.....lb.	.12 - .12	.05 - .06
Potassium carbonate, 80-85%.....lb.	.05 - .05	.07 - .08
Potassium chlorate/powdered and crystals.....lb.	.06 - .07	.55 - .57
Potassium cyanide.....lb.	—	6.10 - 6.25
Potassium hydroxide (caustic potash).....100 lb.	5.60 - 6.00	3.20 - 3.35
Potassium iodide.....lb.	—	.07 - .08
Potassium nitrate.....lb.	.06 - .06	.14 - .15
Potassium permanganate.....lb.	.13 - .13	.90 - .95
Potassium prussiate, red.....lb.	—	.32 - .33
Potassium prussiate, yellow.....lb.	.32 - .32	—
Rochelle salts (see sodium potas. tartrate).....lb.	—	.06 - .07
Salammoniac, white, granular.....lb.	.06 - .06	.08 - .08
Salammoniac, gray, granular.....lb.	.08 - .08	1.45 - 1.60
Salsoda.....100 lb.	1.20 - 1.40	—
Salt cake (bulk).....ton	18.00 - 21.00	—
Soda ash, light, 58 per cent flat, bags, contract.....100 lb.	1.60 - 1.67	2.00 - 2.25
Soda ash, light, 58 per cent flat, bags, resale.....100 lb.	1.75 - 1.80	1.85 - 2.35
Soda ash, dense, in bags, resale.....100 lb.	1.85 - 1.90	1.95 - 2.40
Sodium acetate.....lb.	.06 - .06	.07 - .07
Sodium bicarbonate.....100 lb.	1.75 - 1.85	1.90 - 2.30
Sodium bichromate.....lb.	.07 - .07	.08 - .08
Sodium bisulphate (nitre cake).....ton	4.50 - 4.60	4.65 - 5.50
Sodium bisulphate powdered, U.S.P.....lb.	.04 - .04	.04 - .05
Sodium chloride.....lb.	.06 - .06	.07 - .07
Sodium chloride, long ton.....long ton	12.00 - 13.00	—
Sodium cyanide.....lb.	.19 - .21	.21 - .25
Sodium fluoride.....lb.	.09 - .10	.10 - .10
Sodium hydroxide (caustic soda) solid, 76 per cent flat, drums, contract.....100 lb.	3.35 - 3.40	3.75 - 4.00
Sodium hydroxide (caustic soda) solid, 76% flat, drums, resale.....100 lb.	3.70 - 3.75	3.80 - 4.00
Sodium hydroxide (caustic soda), ground and flake, contracts.....100 lb.	3.80 - 3.90	4.25 - 4.40
Sodium hydroxide (caustic soda) ground and flake, resale.....100 lb.	4.00 - 4.15	4.40 - 4.60
Sodium hyposulphite.....lb.	.02 - .03	.03 - .03
Sodium nitrite.....lb.	.07 - .08	.08 - .08
Sodium peroxide, powdered.....lb.	.28 - .30	.31 - .35
Sodium phosphate, dibasic.....lb.	.03 - .04	.04 - .04
Sodium potassium tartrate (Rochelle salts).....lb.	—	.18 - .21
Sodium prussiate, yellow.....lb.	.21 - .21	.21 - .22
Sodium silicate, (40 deg. in drums).....100 lb.	.80 - 1.00	1.05 - 1.25
Sodium silicate, (60 deg. in drums).....100 lb.	2.25 - 2.40	2.45 - 2.75
Sodium sulphate, crystals (Glauber's salt).....100 lb.	.90 - 1.00	1.05 - 1.50
Sodium sulphide, (acid, 60-62 per cent (conc.)).....lb.	.04 - .04	.04 - .05
Sodium sulphite, crystals.....lb.	.03 - .03	.03 - .04
Strontium nitrate, powdered.....lb.	.09 - .10	.10 - .12
Sulphur chloride, yellow.....lb.	.04 - .05	.05 - .06
Sulphur, crude.....ton	18.00 - 20.00	—
Sulphur dioxide, liquid, cylinders extra.....lb.	.08 - .08	.09 - .10
Sulphur (sublimed), flour.....100 lb.	—	2.25 - 3.10
Sulphur, roll (brimstone).....100 lb.	2.00 - 2.15	2.20 - 2.70
Talc—imported.....ton	30.00 - 40.00	—
Talc—domestic powdered.....ton	18.00 - 25.00	—
Tin bichloride.....lb.	.09 - .09	.09 - .10
Tin oxide.....lb.	—	.35 - .37
Zinc carbonate.....lb.	.14 - .14	.14 - .15
Zinc chloride, gran.....lb.	.51 - .06	.06 - .06
Zinc cyanide.....lb.	.42 - .44	.45 - .47
Zinc oxide, XX.....lb.	.07 - .08	.08 - .08
Zinc sulphate.....100 lb.	2.75 - 3.00	3.05 - 3.30

Coal-Tar Products

NOTE—These prices are for original packages in large quantities f.o.b. N.Y.:

Alpha-naphthol, crude.....lb.	\$1.00 - \$1.05
Alpha-naphthol, refined.....lb.	1.10 - 1.15
Alpha-naphthylamine.....lb.	.28 - .30
Aniline oil, drums extra.....lb.	.14 - .16
Aniline salts.....lb.	.22 - .24
Anthracene, 80% in drums (100 lb.).....lb.	.75 - 1.00
Benzaldehyde U.S.P.....lb.	1.30 - 1.35
Benzene, pure, water-white, in drums (100 gal.).....gal.	.30 - .35
Benzene, 90%, in drums (100 gal.).....gal.	.28 - .32
Benzidine, base.....lb.	.85 - .95
Benzidine sulphate.....lb.	.80 - .85
Benzoic acid, U.S.P.....lb.	.65 - .67
Benzoate of soda, U.S.P.....lb.	.53 - .55
Benzyl chloride, 95-97%, refined.....lb.	.25 - .27
Benzyl chloride, tech.....lb.	.20 - .23
Beta-naphthol benzoate.....lb.	3.75 - 4.00
Beta-naphthol, sublimed.....lb.	.50 - .55
Beta-naphthol, tech.....lb.	.22 - .25
Beta-naphthylamine, sublimed.....lb.	1.50 - 1.60
Carbazol.....lb.	.75 - .90
Cresol, U. S. P., in drums (100 lb.).....lb.	.12 - .15
Ortho-cresol, in drums (100 lb.).....lb.	.16 - .18
Cresylic acid, 97-99%, straw color, in drums.....gal.	.56 - .65
Cresylic acid, 95-97%, dark, in drums.....gal.	.51 - .58
Dichlorobenzene.....lb.	.06 - .09
Diethylaniline.....lb.	.65 - .70
Dimethylaniline.....lb.	.36 - .38
Dinitrobenzene.....lb.	.20 - .22
Dinitrochlorobenzene.....lb.	.21 - .22
Dinitronaphthalene.....lb.	.30 - .32
Dinitrophenol.....lb.	.33 - .35
Dinitrotoluene.....lb.	.22 - .24
Dip oil, 25%, car lots, in drums.....gal.	.24 - .26
Diphenylamine.....lb.	.54 - .56
H-acid.....lb.	.80 - .85
Meta-phenylenediamine.....lb.	.85 - 1.00
Monochlorobenzene.....lb.	.10 - .11
Monothylaniline.....lb.	1.00 - 1.20
Naphthalene crushed, in bbls.....lb.	.06 - .06
Naphthalene, flake.....lb.	.06 - .07
Naphthalene, balls.....lb.	.07 - .08
Naphthionine of soda.....lb.	.58 - .65
Naphthionine acid, crude.....lb.	.65 - .70
Nitrobenzene.....lb.	.10 - .12
Nitro-naphthalene.....lb.	.30 - .35

Nitro-toluene.....	lb.	\$0.15	— \$0.17
N-W acid.....	lb.	1.15	— 1.30
Ortho-amidophenol.....	lb.	2.10	— 2.15
Ortho-dichlor-benzene.....	lb.	.17	— .20
Ortho-nitro-phenol.....	lb.	.75	— .77
Ortho-nitro-toluene.....	lb.	.10	— .13
Ortho-toluidine.....	lb.	.12	— .14
Para-amidophenol, base.....	lb.	1.25	— 1.30
Para-amidophenol, HCl.....	lb.	1.30	— 1.35
Para-dichlorbenzene.....	lb.	.17	— .20
Paranitroaniline.....	lb.	.72	— .80
Para-nitrotoluene.....	lb.	.55	— .65
Para-phenylenediamine.....	lb.	1.55	— 1.60
Para-toluidine.....	lb.	.85	— .90
Phthalic anhydride.....	lb.	.35	— .38
Phenol, U. S. P., drums.....	lb.	.14	— .18
Pyridine.....	gal.	1.75	— 2.75
Resorcinol, technical.....	lb.	1.30	— 1.35
Resorcinol, pure.....	lb.	1.75	— 1.80
R-salt.....	lb.	.55	— .60
Salicylic acid, tech., in bbls.....	lb.	.23	— .24
Salicylic acid, U. S. P.....	lb.	.25	— .26
Solvent naphtha, water-white, in drums, 100 gal.....	gal.	.27	— .32
Solvent naphtha, crude, heavy, in drums, 100 gal.....	gal.	.14	— .18
Sulphanilic acid, crude.....	lb.	.24	— .26
Toluidine.....	lb.	1.20	— 1.30
Toluidine, mixed.....	lb.	.30	— .35
Toluene, in tank cars.....	gal.	.25	— .28
Toluene, in drums.....	gal.	.30	— .35
Xylidines, drums, 100 gal.....	lb.	.40	— .45
Xylene, pure, in drums.....	gal.	.40	— .45
Xylene, pure, in tank cars.....	gal.	.45	— .50
Xylene, commercial, in drums, 100 gal.....	gal.	.35	— .35
Xylene, commercial, in tank cars.....	gal.	.30	— .30

Waxes

All prices remain quotably unchanged

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.....	280 lb.	\$5.75	— \$6.20
Rosin E-I.....	280 lb.	6.25	— 6.65
Rosin K-N.....	280 lb.	6.70	— 7.80
Rosin W. G.-W. W.....	280 lb.	7.85	— 8.40
Wood rosin, bbl.....	280 lb.	6.25	—
Spirits of turpentine.....	gal.	1.14	— 1.16
Wood turpentine, steam dist.....	gal.	.85	—
Wood turpentine, dest. dist.....	gal.	.70	— .70
Pine tar pitch, bbl.....	200 lb.	6.00	—
Tar, kiln burned, bbl. (500 lb.).....	bbl.	9.50	—
Retort tar, bbl.....	500 lb.	9.00	—
Rosin oil, first run.....	gal.	.36	—
Rosin oil, second run.....	gal.	.38	—
Rosin oil, third run.....	gal.	.46	—
Pine oil, steam dist., sp.gr. 0.930-0.940.....	gal.	1.00	—
Pine oil, pure, dest. dist.....	gal.	.95	—
Pine tar oil, ref., sp.gr. 1.025-1.035.....	gal.	.46	—
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.....	gal.	.35	—
Pine tar oil, double ref., sp.gr. 0.965-0.990.....	gal.	.75	—
Pine tar, ref., thin, sp.gr. 1.080-1.060.....	gal.	.25	—
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990.....	gal.	.25	—
Pine wood creosote, ref.....	gal.	.52	—

Fertilizers

Ammonium sulphate, f.a.s., N. Y., double bags.....	100 lb.	3.55	— 3.60
Blood, dried, f.o.b., N. Y.....	unit	4.50	—
Bone, 3 and 50, ground, raw.....	ton	37.00	— 39.00
Fish scrap, dom., dried, f.o.b. works.....	unit	3.10	— 3.20
Nitrate of soda.....	100 lb.	2.55	— 2.60
Tankage, high grade, f.o.b. Chicago.....	unit	3.50	— 3.60
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%.....	ton	3.50	— 4.00
Tennessee, 78-80%.....	ton	7.00	— 8.00
Potassium murate, 80%.....	ton	33.00	— 34.00
Potassium sulphate.....	unit	1.00	—

Crude Rubber

Para-Upriver fine.....	lb.	\$0.19	— .20
Upriver coarse.....	lb.	.13	— .13
Upriver caueho ball.....	lb.	.13	— .13
Plantation—First latex crepe.....	lb.	.14	— .14
Ribbed smoked sheets.....	lb.	.14	— .14
Brown crepe, thin, clean.....	lb.	.13	—
Amber crepe No. 1.....	lb.	.14	—

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.....	lb.	\$0.12	— \$0.13
Castor oil, AA, in bbls.....	lb.	.13	— .13
China wood oil, in bbls.....	lb.	.12	— .12
Coconut oil, Ceylon grade, in bbls.....	lb.	.08	— .08
Coconut oil, Ceylon grade, in bbls.....	lb.	.09	— .09
Corn oil, crude, in bbls.....	lb.	.10	— .10
Cottonseed oil, crude (f. o. b. mill).....	lb.	.08	— .08
Cottonseed oil, summer yellow.....	lb.	.10	— .10
Cottonseed oil, winter yellow.....	lb.	.11	— .11
Linseed oil, raw, car lots (domestic).....	gal.	.88	— .89
Linseed oil, raw, tank cars (domestic).....	gal.	.84	— .85
Linseed oil, boiled, in 5-bbl lots (domestic).....	gal.	.90	— .91
Olive oil, denatured.....	gal.	1.15	— 1.17

Palm, Lagos.....	lb.	.07	— .07
Palm, Niger.....	lb.	.06	— .06
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.09	— .09
Peanut oil, refined, in bbls.....	lb.	.12	— .12
Rapeseed oil, refined, in bbls.....	gal.	.82	— .85
Rapeseed oil, blown, in bbls.....	gal.	.88	— .89
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.11	—
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.09	—

FISH

Light pressed menhaden.....	gal.	\$0.53	—
Yellow bleached menhaden.....	gal.	.54	— .55
White bleached menhaden.....	gal.	.56	— .57
Blown menhaden.....	gal.	.61	—
Whale Oil, No. 1, crude, tanks, coast.....	gal.	.45	— .48

Miscellaneous Materials

Shellac, orange fine.....	lb.	.71	— .72
Shellac, orange superfine.....	lb.	.73	— .74
Shellac, A. C. garnet.....	lb.	.67	— .68
Shellac, T. N.....	lb.	.70	— .71

Other Prices Same as Previous Report

Ferro-Alloys

Ferrotitanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	— \$225.00
Ferrocromium, per lb. of Cr contained, 6-8% carbon, carlots.....	lb.	.10	— .10
Ferrocromium, per lb. of Cr contained, 4-6% carbon, carlots.....	lb.	.10	— .11
Ferromanganese, 78-82% Mn, domestic.....	gross ton	67.50	— 69.00
Ferromanganese, 78-82% Mn, German.....	gross ton	67.00	— 67.50
Spiegeleisen, 19-21% Mn.....	gross ton	36.00	—
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	1.85	— 2.00
Ferrosilicon, 10-15%.....	gross ton	38.00	— 40.00
Ferrosilicon, 50%.....	gross ton	58.00	— 60.00
Ferrosilicon, 75%.....	gross ton	115.00	— 120.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.42	— .45
Ferro-uranium, 35-50% of U, per lb. of U content.....	lb.	6.00	—
Ferrovanadium, 30-40% per lb. of contained V.....	lb.	3.50	— 4.00

Ores and Semi-finished Products

All f.o.b. New York Unless Otherwise Stated

Bauxite, domestic, crushed and dried.....	net ton	\$6.00	— \$9.00
Chromite ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	19.00	— 21.00
Chromite ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	ton	18.00	— 21.00
Coke, foundry, f.o.b. ovens.....	net ton	16.50	—
Coke, furnace, f.o.b. ovens.....	net ton	16.00	—
Fluorspar, gravel, f.o.b. mines, New Mexico.....	net ton	15.00	—
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	17.50	— 19.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01	— .01
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.29	—
Manganese ore, chemical (MnO ₂).....	net ton	60.00	— 65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.45	— .50
Monasite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	27.00	—
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.10	— .11
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.12	— .13
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	Nominal	—
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.12	—
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.00	— 3.25
Tungsten, wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.25	— 3.50
Uranium ore (carnotite) per lb. of U ₂ O ₅	lb.	1.25	— 1.75
Uranium oxide, 96% per lb. contained U ₂ O ₅	lb.	2.25	— 2.50
Vanadium pentoxide, 99%.....	lb.	12.00	— 14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—
Zircon, washed, iron free, f.o.b. Pablo, Florida.....	lb.	.04	— .13

Non-Ferrous Metals

All f.o.b. New York Unless Otherwise Stated

	Cents per Lb.
Copper, electrolytic.....	14.075
Aluminum, 98 to 99 per cent.....	19.10
Antimony, wholesale lots, Chinese and Japanese.....	5.25
Nickel, ordinary (ingot).....	36.00
Nickel, electrolytic.....	39.00
Nickel, electrolytic, resale.....	32.00-33.00
Nickel, ingot and shot, resale.....	30.00-31.00
Monel metal, shot and blocks.....	32.00
Monel metal, ingots.....	35.00
Monel metal, sheet bars.....	38.00
Tin, 5-ton lots, Straits.....	32.25
Lead, New York, spot.....	5.75
Lead, E. St. Louis, spot.....	5.525
Zinc, spot, New York.....	6.60-6.65
Zinc, spot, E. St. Louis.....	6.20-6.25

OTHER METALS

Silver (commercial).....	oz.	\$0.69	—
Cadmium.....	lb.	1.20-1.25	—
Bismuth (500 lb. lots).....	lb.	2.00-2.10	—
Cobalt.....	lb.	3.00-3.25	—
Magnesium, ingots, 99 per cent.....	lb.	1.15-1.25	—
Platinum.....	oz.	93.00	—
Iridium.....	oz.	180.00-185.00	—
Palladium.....	oz.	55.00	—
Mercury.....	75 lb.	55.00	—

Industrial

Financial, Construction and Manufacturers' News

Industrial Developments

PAPER—The Hinde & Dauch Paper Co., manufacturer of corrugated paper products, has advanced production to full capacity at its Gloucester City, N. J., works, with day and night working forces.

The United Paper Board Co., Wabash, Ind., has resumed operations at its plant with a full working force of about 150 men, following a curtailment since last June. It is expected to maintain capacity production for an indefinite period. The coating mills at the plant are on a full production schedule, giving employment to a large working force. Orders on hand insure continuance on this basis for some time to come.

CERAMIC—The Harbison-Walker Refractories Co., Pittsburgh, Pa., is developing maximum capacities at its different plants in central Pennsylvania, and incoming orders are considerably in excess of production. A scarcity of labor in the vicinity of Mount Union, Pa., is handicapping the output at plants in this district.

Employees of the Toronto Fire Clay Co., Toronto, O., out on strike for 2 weeks past, have returned to the plant. The men have been granted an increase in wages of 5c. an hour.

Lack of fuel in the vicinity of Cleveland, O., has caused the Akron Sewer Pipe Co. to close two of its plants at Uhrichsville. The Cleveland Builders' Supply & Brick Co. has been compelled to curtail production at three of its local brick-manufacturing plants.

RUBBER—The Lycoming Rubber Co., Williamsport, Pa., has resumed operations at its plant, on a full-capacity basis, following a few weeks' shut down.

Automobile tire production at Akron, O., and vicinity during July broke all previous records, with gross output at the different mills for this month estimated at 2,750,000 tires. Up to the present time more than 11,000,000 tires have been manufactured in this section, dating from the first of the year. The leading companies are maintaining the following daily production schedules: B. F. Goodrich Co., 20,000 tires; Firestone Tire & Rubber Co., 25,000; Goodyear Tire & Rubber Co., 26,000; and the Miller Tire & Rubber Co., 7,500.

IRON AND STEEL—The Tennessee Coal, Iron & Railroad Co. is making ready for the immediate blowing in of its No. 1 blast furnace at Ensley, Ala.

The Follansbee Brothers Co., Pittsburgh, Pa., has resumed production at its sheet and tinplate mills at Toronto, O., and Follansbee, W. Va., following a temporary shut down due to coal shortage.

The Bethlehem Steel Co., Bethlehem, Pa., is maintaining an operating schedule of about 80 per cent of capacity at its local mills.

A shortage of coal and coke has caused the Midvale Steel & Ordnance Co. to bank its No. 2 blast furnace at Coatesville, Pa. It will remain idle until conditions improve.

The Brier Hill Steel Co., Youngstown, O., has resumed operations at six of the eleven open-hearth furnaces recently closed down on account of fuel shortage. Gas burners have been installed to insure continuous service.

Following continuous operation for a number of weeks past, the Illinois Steel Co., has banked two of its furnaces at South Chicago, Ind., and two at Gary, Ind., reducing production to an 84 per cent of normal basis. Fuel shortage is responsible for the curtailment.

The American Steel Foundries, Chicago, Ill., is maintaining production on a basis of from 75 to 80 per cent of capacity at its different plants. The company has a coal supply on hand sufficient to insure continuous operation for about 60 days, and has booked orders to allow production on the basis noted for the remainder of the year.

The Inland Steel Co., Chicago, Ill., is holding operations on a basis of 65 to 70 per cent, the same rate as has been prevailing for some time past.

Coal and coke shortage has caused the Jones & Laughlin Steel Co., Pittsburgh, Pa., to bank one of its Eliza blast furnaces.

The Trumbull Steel Co., Youngstown, O., is maintaining capacity production at its mills, with one furnace now idle on account of fuel shortage.

The Youngstown Sheet & Tube Co., Youngstown, O., is continuing at three of its six blast furnaces, and will increase operations as soon as fuel is available.

METALS—The American Smelting & Refining Co. is running full at its smelter of seven lead furnaces at its plant at Chihuahua, Mexico. The tonnage output is larger than ever before in the history of the plant.

Owing to inability to obtain railroad shipping facilities on account of the strike, the Aluminum Co. of America, Pittsburgh, Pa., has closed down its sheet mill at Alcoa, near Knoxville, Tenn.

The Anaconda Copper Mining Co. is resuming operations at its Emma properties at Butte, Mont., closed down since January, 1921, and devoted to zinc, silver and lead production. About 125 men will be employed. This is the fourteenth property of the company to be reopened in this district.

MISCELLANEOUS—The American Vulcanized Fiber Co., has reached capacity production at its plants at Wilmington and Newark, Del., for the first time in more than a year past.

The Long Valley Paint Co., Hancock, Pa., is arranging for immediate resumption of operations at its local plant, following a long period of idleness.

The Atlas Powder Co., Tamaqua, Pa., has increased operations at its local mills from 5 to 6 days weekly. Incoming orders insure this rate of production for some time to come.

Despite the general custom of closing down among the glass plants at Millville, N. J., the last of July of each year, a number of plants are continuing owing to the heavy orders on hand. These include the Millville Bottle Works, which will keep two furnaces active; and the F. C. Wheaton Co., manufacturer of druggists' glassware.

Construction and Operation

Arkansas

FORT SMITH—The Equitable Powder Co. has tentative plans under consideration for the rebuilding of the portion of its plant, destroyed by fire, caused by an explosion, July 28. An official estimate of loss has not been announced.

California

PITTSBURG—The Pioneer Rubber Co., 68 Sacramento St., San Francisco, has taken bids and will soon award contract for the construction of its proposed local building, 1-story, 80x200 ft., estimated to cost about \$150,000. Benjamin G. McDougall, 381 Bush St., San Francisco, is architect.

LOS ANGELES—The Egyptian Lacquer Mfg. Co., 5 East 40th St., New York, N. Y., has completed plans and is taking bids for the construction of a new 1-story building, 50x100 ft., on Maple Ave., near 11th St., Los Angeles, for a Pacific Coast works. Mott M. Marston, 533 San Fernando Bldg., Los Angeles, is architect.

SAN FRANCISCO—The Pacific Gas & Electric Co., 445 Sutter St., will construct an artificial gas plant at Army and DeHaro Sts., to cost close to \$100,000.

Connecticut

MIDDLETOWN—The Standard Oil Co., 26 Broadway, New York, N. Y., has plans nearing completion for the construction of a new oil and gasoline distributing plant on the Connecticut River, near Middletown. It is said that the works will cost in excess of \$3,000,000, with equipment.

Florida

ST. PETERSBURG—The Texas Refining Co. has plans under way for the construction of a new oil plant on site acquired at 8th St. and 2nd Ave. The initial works will cost

about \$30,000. It is also planned to construct a gas-plant at this same location.

Indiana

TERRE HAUTE—D. R. Ulmer, Terre Haute, and associates, have organized a new company for the operation of a local plant for the manufacture of sewer pipe, tile, conduit and other burned clay products. The initial works will have an output of about 4,000 lengths of material per day, and this will be increased to about 9,000 at an early date. Ernest Cox will be plant superintendent in charge.

Louisiana

HAYNEVILLE—The Standard Oil Co. of Louisiana, New Orleans, will commence the immediate construction of a new distributing plant at Haynesville, near Shreveport, to provide a total storage capacity of close to 3,000,000 bbl. of oil in this district. The plant with equipment will cost in excess of \$150,000.

Maryland

ILCHESTER—The Mineral Potash Co., 714 Equitable Bldg., Baltimore, has revised plans in preparation for the construction of a new plant at Ilchester, and will call for bids early in the fall. It will be 1-story, 50x150 ft., and is estimated to cost about \$55,000. Louis A. Hazard is president.

SALISBURY—The Hearn Oil Co., 3rd and Commerce Sts., Wilmington, Del., has purchased property on Mill St., and has plans under way for the construction of a new distributing and storage plant with capacity of about 25,000 gal. The initial works will cost close to \$40,000.

BALTIMORE—The Edro Richardson Brass Co., 318 North Holliday St., will break ground at once for the construction of a 1-story addition to its brass foundry, to be located on Monument St., and estimated to cost about \$40,000. Improvements will be made also in the present building. The general contract has been let to J. E. Stansbury, 2852 Pennsylvania Ave.

BALTIMORE—The Baltimore Concrete Products Co. has filed plans for the construction of a new 1-story building on Kate Ave. and the line of the Western Maryland Railroad, to be 35x80 ft.

BALTIMORE—The board of directors, Loyola College, 700 North Calvert St., has awarded a contract to Henry Smith & Sons, 7 East Redwood St., for the construction of a new 2-story chemistry building, to cost about \$200,000. Otto G. Simonson, Casualty Bldg., is architect.

Massachusetts

SALEM—The Wetan Leather Co., Danversport, Mass., has acquired a factory at Hardy St. and Central Ave., Salem, heretofore occupied as an extra works by the Budget & Harrigan Co., for the establishment of a new plant to replace its Danversport works, recently destroyed by fire. Possession will be taken at once and necessary equipment installed.

PEABODY—The Weber, Laemmle Tanning Co., Salem, has acquired the local plant of the Armstrong Leather Co., and will remove its present works to this location at once. Increased facilities will be provided for production. George J. Laemmle, heads the company.

GREENFIELD—The Deerfield Valley Paper Co. has been organized to take over and operate the plant of the Monroe Bridge Paper Co., Monroe Bridge, near Greenfield. Increased manufacture will be arranged.

PEABODY—The Chain Leather Co. has acquired property at 55 Walnut St., for the establishment of a new works.

Michigan

HANCOCK—The chemical laboratory at the Hancock High School was destroyed by fire July 25. In connection with a partial destruction of the building, with total loss estimated in excess of \$200,000.

CLAWSON—A filtration plant will be installed by the Common Council in connection with its proposed new water system. Bonds have been voted.

Mississippi

HATTIESBURG—The Hattiesburg Pine Oil Co., recently organized, is arranging a list of equipment for installation at its proposed new local plant for the manufacture of pine oil, tar, rosin oils, turpentine, etc., to include complete refining equipment, two 52 ft. retorts, pumping apparatus, and power house equipment. The mill will cost close to \$100,000, with machinery. The company is capitalized at \$425,000. Paul S. West is head.

Missouri

ST. LOUIS—The Benjamin Moore Paint Co., 1600 South 2nd St., has awarded a contract to the Hall & Mackay Construction Co., St. Louis, for the rebuilding of the portion of its plant recently destroyed by fire. The work will cost about \$75,000. Mauran, Russell & Crowell, Chemical Bldg., are architects.

ST. JOSEPH—Fire, Aug. 2, destroyed the local lard refining plant of Morris & Co., Union Stock Yards, Chicago, with loss estimated at about \$100,000, including equipment. It is planned to rebuild the works.

Montana

GREAT FALLS—The Anaconda Copper Mining Co., 25 Broadway, New York, N. Y., has tentative plans under consideration, for the construction of a new brass fabricating plant at its mills at Great Falls. It is estimated to cost in excess of \$500,000.

New Jersey

GLOUCESTER CITY—The Armstrong Cork Co., 24th St., Pittsburgh, Pa., with district plant at Camden, N. J., will remodel and improve the local building at Delaware Ave. and Ellis St., formerly used by the Ancona Printing Co., recently acquired. For the present the structure will be used as a general service and operating building, and later machinery will be installed to convert into a manufacturing works.

TRENTON—The Panelyte Board Co., Smith Bldg., 119-25 North Montgomery St., lately organized with a capital of \$300,000 in preferred stock and 4,000 shares of common stock, no par value, has acquired property on Whitehead Road for the construction of a new plant for the manufacture of fiber board and other fiber products. The initial plant unit, plans for which are being prepared, will be equipped to give employment to about 60 men. D. Manson Sutherland, Jr., has been elected president and manager of the new company; other officials include George G. Connor and S. E. Kaufman.

New York

YONKERS—The Arlington Chemical Co., 100 Hamilton St., is completing plans and will take bids before the close of the month for the construction of a new 4-story plant on Harriett St., Yonkers, to be equipped for a general line of chemicals and chemical byproducts. Timmis & Chapman, 315 5th Ave., New York, are architects. John E. Andrus heads the company.

ROCHESTER—Fire, Aug. 1, destroyed a portion of the plant of the Rochester Composite Brick Co., with loss estimated at about \$100,000, including equipment and stock.

BUFFALO—The Upco Petroleum Co. will commence the immediate construction of its proposed new local plant on site recently acquired on Military Road. The company has a tract of about 2 acres of land, and expects to utilize it entirely for different plant units.

LONG ISLAND CITY—The Borough Engineering Department has plans in progress for the construction of two incinerating plants to be located at Woodhaven and Winfield respectively; each plant will comprise two retort units with total capacity of about 100 tons a day, and is estimated to cost about \$275,000. Edward Richardson, Flushing, L. I., and Joseph P. Powers, Rockaway, L. I., are architects.

Ohio

DELAWARE—The Delaware Brass Co. has completed plans and is taking bids for the construction of a new 1-story plant on local site, 50x150 ft.

KENMORE—The Palmer Match Co., 9th floor, Second National Bank Bldg., Akron, O., Charles A. Palmer, president, is arranging a list of equipment for installation at its new plant at Kenmore, for which ground recently was broken, to include complete sulphur house apparatus, mixing machinery and other mechanical equipment. The plant will be 2-story and basement, and is estimated to cost in excess of \$500,000. Henry & Murphy, Second National Bank Bldg., Akron, are engineers.

Oklahoma

DEWEY—The Co-operative Rubber Co. will commence the immediate construction of a new plant on local site for the manufacture of a general line of rubber products.

DUNCAN—The Pauline Oil & Gas Co. has commenced the construction of a new oil-refining plant on property lately acquired

about 5 miles south of Duncan. The plant will be equipped to handle about 700 bbl. of crude oil per day, and is estimated to cost close to \$70,000.

CUSHING—The Cushing Refining & Gasoline Co., a subsidiary of the Mulberry Oil Co., capitalized at \$500,000, has acquired the local oil refinery of Gustafson & Spencer, with capacity of about 1,500 bbl. per day. The company will make extensions and improvements and will operate the plant in connection with its new 3-unit gasoline compression plant, now in course of construction at Ingalls, Okla.

Oregon

PORTLAND—The Steno Carbon Paper Co. has awarded a contract to the Hurley-Mason Co., Gasco Bldg., for the construction of a new 1-story plant on the Sandy Blvd., for the manufacture of carbon and other papers. It will cost about \$60,000, including equipment.

Pennsylvania

LANCASTER—A 1-story foundry will be constructed by the Burnham Boiler Works, Irvington-on-Hudson, N. Y., in connection with its new local plant on the Dillville Road, Lancaster, estimated to cost about \$200,000. Frank D. Chase, Inc., 645 North Michigan Ave., Chicago, Ill., is architect and engineer.

PHILADELPHIA—The Philadelphia Paper Mfg. Co., Nixon St. and River Road, will commence the immediate erection of a new 1-story building at its plant.

PHILADELPHIA—The Paper Manufacturers' Co., 526 Cherry St., with plant at 13th and Noble Sts., has purchased property at 408-18 North 5th St., for a consideration of about \$72,500, and will use the land for proposed plant expansion.

Texas

NAVASOTA—The Planters' Cotton Mill Co. has tentative plans under consideration for the rebuilding of its local plant, partially destroyed by fire recently, with loss estimated at close to \$60,000.

NILE CITY—The Kerr Tire Co. has acquired a local site, and has work under way on a new plant for the manufacture of automobile tires, tubes, etc. The initial works will be equipped for a capacity of about 2,000 tires per day.

ROBSTOWN—The Industrial department of the local Chamber of Commerce is considering the establishment of a new brick-manufacturing plant near the city. A company will be organized to operate the factory, or arrangements made with an existing brick manufacturing company to construct and operate the works. A fund to provide for the erection is being arranged.

SABINE—The Magnolia Oil Co. will rebuild the portion of its local plant, recently destroyed by fire, with loss estimated at close to \$175,000.

West Virginia

NITRO—The Carrier Chemical Co., 604 Kanawha National Bank Bldg., Charleston, W. Va., has preliminary plans under way for the construction of a new plant at Nitro, for the manufacture of a number of chemicals and chemical byproducts. C. F. Carrier, Jr., is chemical engineer.

FALLING SPRING—The F. A. Jones Stone & Lime Co., Zanesville, O., F. A. Jones, president, has acquired a tract of limestone property in this vicinity, and plans for the initial development of over 35 acres of the site. A mill and other mechanical structures will be built.

Wisconsin

RACINE—S. C. Johnson & Son, manufacturer of waxes, polishes, etc., will commence the immediate construction of the superstructure of its new 4-story and basement plant addition on 16th St. J. Mander Matson, Robinson Bldg., is architect.

Canada

ST. JOHN, N. B.—The Nashwaak Pulp & Paper Co. has plans in progress for extensive additions and improvements in its local mills, to increase the capacity from about 60 to 80 tons of pulp a day, with corresponding advance in the paper making division of the works. The project will cost about \$500,000, including equipment. The company is operated by officials of the Oxford Paper Co., 200 5th Ave., New York, and the Bryant Paper Co., Kalamazoo, Mich.; Hugh J. Christolm and Felix Pagenstacher are presidents of the respective companies in the order noted.

Capital Increases, Etc.

THE REFINERS' OIL Co., Dayton, O., has filed notice of increase in capital from \$400,000 to \$700,000.

THE SAVOY DRUG & CHEMICAL Co., 28 East Kinzie St., Chicago, Ill., has filed notice of increase in capital from \$12,000 to \$75,000.

THE WATAB PAPER Co., Sartell, Minn., is disposing of a bond issue of \$1,250,000, the proceeds to be used in part for extensions, general expansions, etc. David E. Town is president.

THE CONTINENTAL RUBBER Co. OF NEW YORK, 120 Broadway, New York, N. Y., has filed notice of increase in capital from \$50,000 to \$370,000.

THE JAMES BOLAND RENDERING & FERTILIZER Co., Jackson, Mich., has filed notice of dissolution under state laws.

THE UNITED GLUE Co., Indianapolis, Ind., has filed notice of dissolution under state laws.

THE DIAMOND BRICK & TILE Co., Cleveland, O., has filed notice of increase in capital from \$50,000 to \$100,000.

THE VIRGINIA-CAROLINA CHEMICAL Co., Richmond, Va., has arranged for a bond issue of \$12,500,000, the proceeds to be used for additions to working capital, expansion, etc. C. G. Wilson is president.

THE CHESAPEAKE PAPERBOARD Co., Baltimore, Md., has arranged for an increase of \$150,000 in capital for proposed expansion.

THE LINCOLN MILLS, LLD., Merritton, Ont., manufacturer of paper products, has arranged for a bond issue of \$1,000,000, the proceeds to be used for additions to working capital, general operations, expansion, etc.

Arthur H. Wood and S. Edward Murray, Jr., receivers for the EMPIRE TIRE & RUBBER Co., Trenton, N. J., will offer the plant and property of the company at a public sale to be held in September, the exact date to be soon decided.

W. R. Shaffer, Henry W. Brooks, Jr., and P. P. Nelson have been appointed receivers for the HALLTOWN PAPER BOARD Co., Halltown, W. Va.

New Companies

THE FIBER PRODUCTS Co., Newark, N. J., has been incorporated with a capital of \$100,000, to manufacture fiber specialties. The incorporators are Edward E. and Arthur F. Felsberg, and Cyrus H. Vall, 784 Broad St., Newark.

THE NEW ENGLAND BRASS MFG. Co., Danbury, Conn., has been incorporated with a capital of \$12,000, to manufacture brass products. The incorporators are Frank Perlin, M. E. Krebs, and M. M. Quamruddin, 100 White St., Danbury.

THE SURE LIVE TRANSPLANTER Co., New York, N. Y., care of L. A. Safian, 291 Broadway, representative, has been incorporated with a capital of \$100,000, to manufacture chemicals and chemical byproducts. The incorporators are C. H. Donner, A. Abt and E. Schwab.

THE BURDICK-BAXTER PAINT Co., Indianapolis, Ind., has been incorporated with a capital of \$25,000, to manufacture paints, oils, etc. The incorporators are Oliver P. Ensley and Malcolm Baxter, both of Indianapolis.

THE OZARK OIL Co., Detroit, Mich., care of the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del., representative, has been incorporated with a capital of \$250,000, to manufacture petroleum products. The principal incorporator is H. M. Senter, Detroit.

THE BARKER-BRIGGS CHEMICAL Co., Louisville, Ky., has been incorporated with a capital of \$25,000, to manufacture chemicals and chemical byproducts. The incorporators are Daniel Briggs, Rowland A. Barker and Herbert F. Boehl, all of Louisville.

THE ROYAL BRASS FOUNDRY Co., 39 New York Ave., Newark, N. J., has filed notice of organization to manufacture brass, bronze and other metal castings. Gothar B. Elsner, 20 Beech St., heads the company.

THE SIMPSON LEATHER Co. INC., Boston, Mass., has been incorporated with a capital of \$25,000, to manufacture leather products. Charles A. Simpson, Trenton St., Melrose, Mass., is president and treasurer.

THE MANATEE COUNTY FERTILIZER Co., Bradentown, Fla., has been incorporated with a capital of \$25,000, to manufacture commercial fertilizer products. J. H. Humphries is president; I. T. Williams, vice-president; and H. O. Horner, secretary, all of Bradentown.

Manufacturers' Catalogs

THE DELEVAN SMELTING & REFINING WORKS, INC., Brooklyn, N. Y., care of J. M. Cleary, 25 Henry St., Brooklyn, representative, has been incorporated with a capital of \$100,000, to operate a metal smelting and refining plant. The incorporators are A. I. and S. X. Toorock.

THE DIXIE WAX PAPER CO., Dallas, Tex., has been incorporated with a capital of \$20,000, to manufacture waxed and other papers. The incorporators are R. G. Smythe, J. Irwin and G. C. Embry, all of Dallas.

THE JOHN L. MORRIS OIL CO., Cuyahoga Falls, O., care of the Colonial Charter Co., Ford Bldg., Wilmington, Del., representative, has been incorporated with a capital of \$150,000, to manufacture oil products. The incorporators are L. E. James, John L. Morris and Maurice Betts.

THE NEW ERA MICA CO., Penland, N. C., has been incorporated with a capital of \$10,000, to manufacture mica products. The incorporators are Paul Willis and John V. Cox, both of Penland.

THE UNITED STATES PAPER MFG. CORP., 543 Calvert Bldg., Baltimore, Md., has been incorporated with a capital of \$3,000,000, to manufacture pulp and paper products. The incorporators are Johnston V. Best, Wendell D. Allen and Lewis C. Merryman.

THE HERCULES RUBBER PRODUCTS CORP., Brooklyn, N. Y., care of the United States Corporation Co., 65 Cedar St., New York, has been incorporated under Delaware laws, with a capital of \$7,600,000, to manufacture rubber products. The incorporators are Paul M. Richards, and George W. Bryan, Brooklyn; and Winfield Clearwater, Rutherford, N. J.

CONLEY & STRAIGHT, INC., Providence, R. I., has been incorporated with a capital of 250 shares of stock, no par value, to operate a metal refining plant. The incorporators are John A. Straight, George W. Bugbee, and T. H. Conley, 50 Lillian Ave., Providence.

THE TALMAGE MFG. CO., 3525 Ogden Ave., Chicago, Ill., has been incorporated with a capital of \$5,000, to manufacture chemicals and chemical byproducts. The incorporators are Maurice M. Talmage, I. Wineberg and Joseph Kampner.

THE COLUMBIA STEEL & TUBE CORP., New York, N. Y., has been incorporated with a capital of \$25,000, to manufacture steel tubing, etc. The incorporators are H. Lipton, L. Bardl, and A. Wynehouse, care of Slade & Slade, 200 Broadway, New York, representatives.

THE INTERSTATE CHEMICAL FOUNDATION, INC., care of the Corporation Service Co., Equitable Bldg., Wilmington, Del., has been incorporated under state laws, with capital of \$2,500,000, to manufacture chemicals and chemical byproducts.

THE SOL CASTING CO., Linden, N. J., has been incorporated with a capital of 100 shares of stock, no par value, to manufacture iron, steel and other metal castings. The incorporators are Raymond F. Sturges, Joseph Oxman, and Henry Lipp, Linden. The last noted represents the company.

THE ECONOMY SOAP CO., Buffalo, N. Y., care of William O. Shields, Morgan Bldg., representative, has been incorporated with a capital of \$15,000, to manufacture soaps and kindred products. The incorporators are J. F. Wagner and S. S. Knaler.

EL DORADO SPRINGS DEVELOPMENT CO., El Dorado, Mo., has been incorporated with a capital of \$200,000, to manufacture zinc products. The incorporators are William True, A. B. Stricklett and M. A. O'Connor.

THE PURITAN OIL & REFINING CO., New York, N. Y., care of the United States Corporation Co., 65 Cedar St., representative, has been incorporated under Delaware laws, with a capital of \$10,000,000, to manufacture petroleum products.

E. J. TODD, INC., New Haven, Conn., has been incorporated with a capital of \$50,000, to manufacture rubber products. The incorporators are Alonzo P. Adams, Great Barrington, Mass.; R. H. Cameron, Hamden, Conn.; and T. C. Hadden, 195 Church St., New Haven.

THE OHIO VALLEY SHALE OIL & DEVELOPMENT CO., Huntington, W. Va., has been incorporated with a capital of \$150,000, to manufacture petroleum products. The incorporators are H. H. Brown, C. B. Hill and R. E. Petty.

HENRY SHAPNER, SONS & CO., INC., Springfield, Mass., has been incorporated with a capital of \$125,000, to manufacture leather products. Henry Shapner is president; and Sidney Shapner, 149 Sumner Ave., Springfield, treasurer.

THE ALLIS-CHALMERS MANUFACTURING CO., Milwaukee, Wis., has issued two new bulletins. "Synchronous Motors" is the title of Bull. 1124, in which there are numerous illustrations of this type of motor suited to various industrial applications, and their use for belted, coupled or direct-connected service. Particular attention is called to the use of these motors for driving air compressors, motor generator sets, also their use for rubber mill drive, flour mill drive, ice-making and refrigerating machinery, paper-making machinery, and for driving mine fans, pumps, etc. Bulletin 1109 is on "Distribution Transformers" having ratings of 200 kva. and smaller, suitable for lighting and power purposes and of the oil immersed self-cooled outdoor type.

THE FULTON CO., Knoxville, Tenn., calls attention to its first general catalog on Siphon Heating Specialties, in which are listed only those articles that relate to heating and temperature regulation.

THE ELECTRO-ALLOYS CO., Elyria, O., has just issued a pamphlet on ThermoAlloy, high-temperature castings.

THE CONVEYORS CORP., Chicago, Ill., has issued an illustrated booklet entitled "Cut Ash Handling Costs," which should be of interest to the power plant executive. The booklet is an exposition of the steam jet conveyor method of ash handling and contains a description of the conveyor and its method of operation. It also gives a list of guarantees offered by the company, which include: Cost per ton of ash handled; cost of repairs per ton of ash handled; non-packing of ashes in the ash storage tank; absence of dust at discharge and non-freezing of ashes in the tank. Copies can be obtained on application.

THE SCIENTIFIC MATERIALS CO., Pittsburgh Pa., has published a special bulletin on the F and F Optical Pyrometer. The bulletin contains a discourse on the general theory of optical pyrometry, with a description of the F and F device and its practical industrial applications. This instrument is well adapted for use in determining temperatures at coke plants, ceramic plants, steel mills, iron furnaces and in other cases of high-temperature measurements where contact with the heated body cannot be made, where the position of the pyrometer must be distant from the heated object or where the temperature to be measured is above the range of thermocouple pyrometers.

THE CENTRAL SCIENTIFIC CO., Chicago, Ill., has issued Catalog R, which is a price list of chemicals and reagents, including Cenco certified chemicals and other standard makes of c.p. and U.S.P. chemicals, certified biological stains, certified rare sugars, culture media, indicators and commercial chemicals for general laboratory use.

THE SURFACE COMBUSTION CO., industrial furnace engineer and manufacturer, of 366 Gerard Ave., Bronx, New York City, is issuing a series of bulletins pertaining to industrial furnaces. Bulletin 3-D is devoted to Surface Combustion Low-Pressure Air-Gas Inspirators, which are readily applicable to any make of gas furnace. Bulletin 5 is entitled "Surface Combustion Oven Furnaces," and describes furnaces for the heat-treatment of both carbon and high-speed steel. Bulletin 6 is devoted to Surface Combustion Pot-Hardening Furnaces. Bulletin 7 is entitled "Surface Combustion Soft Metal Furnaces." Bulletin 8 is devoted to Surface Combustion Galvanizing Baths. Bulletin 16 is entitled "Surface Combustion Shipyard Furnaces." Bulletin 17 is about Surface Combustion Rivet Heaters. Bulletin 18 is entitled "Surface Combustion Small Forges." Bulletin 24 is entitled "Surface Combustion Laboratory Furnaces for High Temperatures."

THE COMBUSTION ENGINEERING CORP., New York, calls attention to a new booklet relative to its powdered coal installation at the River Rouge plant of the Ford Motor Co., which contains some interesting information on operating results at the plant, which has been in operation slightly over a year.

THE AMERICAN NICKEL CORP., Clearfield, Pa., is distributing a booklet, Bull. 101, on "Pure Malleable Nickel" giving a résumé of its properties and uses.

THE NORTHERN EQUIPMENT CO., Erie, Pa., has issued a booklet entitled "Regulating Boiler Feed Water." The subject has been treated in an entirely new way, the object being to cover the subject of boiler feed water regulation completely and yet very briefly. To accomplish this purpose, free use has been made of a graphical method of presentation, charts showing the effect of feed water temperature, etc.

THE HYDRAULIC PRESS MFG. CO., Mount Gilead, O., has recently issued two bulletins which have been got up especially to meet the demands of radio manufacturers for presses for forming and molding such materials as Condensite and Bakelite.

THE JEFFREY MFG. CO., Columbus, O., calls attention to Bulletin 369, dealing with the Jeffrey portable belt conveyor. This conveyor has been designed to meet a demand for a light inexpensive loader that would handle both bulk and package material. This bulletin illustrates and describes this machine. Two or more of the conveyors may be used together to extend storage pile, or the portable belt conveyor may be used as an extension conveyor to storage pile in connection with the Jeffrey portable car unloader. It can be operated by either electric motor or gasoline engine.

THE SHEPARD ELECTRIC CRANE & HOIST CO., Montour Falls, N. Y., has issued illustrated pamphlets on the Shepard Electric Liftabout; Bull. M-3, on Form IX Hoist With Geared Trolley From 1- to 20-Ton Capacity; Bull. M-4, on T-bar Insulator; Bull. M-5, Form 36W Back-Geared Motor Winch From 800- to 3,500-lb. Capacity; Bull. M-7, Form 23 Hoist With Geared Trolley From 1- to 6-Ton Capacity; Bull. M-8, Form 8 Hoist From 1- to 6-Ton Capacity, and a pamphlet on Hoisting Equipment for Ice Plants. This company has also issued a catalog illustrating and describing the Shepard Electric Hoist equipped with Zobel electric motor.

THE INTERNATIONAL NICKEL CO., New York, in Bull. 103 gives some of the uses of Monel metal in the textile industry, including bleaching and dyeing machinery, carpet, felt and hat making, centrifugals, extractors, dehydrators, tanks, warp mercerizing machinery, drying machinery, shaping clips, etc., on spinning machines, rolls and cylinders, carbonizing and scouring machinery, jack-spool heads, drying cans and textile pins.

THE HERCULES POWDER CO., Wilmington, Del., calls attention to a 56-page booklet illustrated with photographs and diagrams, entitled "Eliminating Waste in Blasting." It tells how some progressive companies are preventing waste in blasting, together with recommendations of the Hercules Co. In this book the company endeavors to give users of explosives the benefit of information gathered on the best methods for reducing blasting costs. They will be supplemented with bulletins from time to time. Copies will be sent to anyone interested, upon application to the Advertising Department, Hercules Powder Co., Wilmington, Del.

Coming Meetings and Events

ALPHA CHI SIGMA dinner, during the Chemical Exposition, will be held Thursday, Sept. 14, at 6:30 p.m. at Keen's Chop House, 107 West 44th St., New York City. Members are requested to register at Chem. & Met.'s booth at the Exposition.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Pittsburgh, Pa., Sept. 5 to 9.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Montreal, Sept. 21, 22 and 23. Headquarters will be at the Windsor Hotel.

AMERICAN GAS ASSOCIATION will hold its annual convention and exhibition at Atlantic City, Oct. 23 to 28.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its 126th meeting at San Francisco, Calif., Sept. 25-29, 1922.

AMERICAN SOCIETY FOR STEEL TREATING will hold its International Steel Exposition and Convention in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (EIGHTH) will be held in New York Sept. 11-16.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NATIONAL SAFETY COUNCIL will hold its Eleventh Annual Safety Congress in Detroit, Aug. 28 to Sept. 1.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer, but will resume them in October.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a 3-day national convention in New York, beginning Oct. 18. The general topic of the convention is "Economics of Industry."